

# Why do spouses communicate? Love or interest? A model and some evidence from Cameroon

JOB MARKET PAPER

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**Abstract** In first-hand data from Cameroon, we observe that household members often contribute jointly to intra-household expenditure, while at the same time having very imperfect knowledge of each other's income. This suggests the existence of information-flow problems in the household. This paper is the first theoretical analysis of communication incentives in the household. We assume that one spouse does not observe the income realization of the partner and we study under which conditions an informative exchange of information can take place. We find that, when the only interest spouses have in common is the joint contribution to household public goods, non-communicating is the only equilibrium. We then introduce two possible motives for the existence of a commonality of intents - altruism and intra-household transfers due to productivity advantages - and we determine how those affect communication. We obtain testable predictions for each of the two motives. The Cameroonian data support the communication model based on transfers between spouses.

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# 1 Introduction

*A long marriage is two people trying to dance a duet and two solos at the same time.*

Anne Taylor Fleming

The household, the core of every society and the simplest institution in which people coexist, is the result of a delicate interaction between different individuals. Those often have different preferences, backgrounds and resources. They have to find an optimal way to take decisions and allocate these resources between them. The choices they make have important socio-economic implications, and understanding how households function is essential for public policy to be effective and to be able to properly model economic decisions.

The daily interactions that take place in the household should insure that spouses' decisions are efficient: spouses can easily observe each other's actions, implement social sanctions and inflict non-negligible costs if someone deviates from the first-best allocation. Even if "one explicitly recognizes the existence of several decision-making units, with potentially different preferences that do not systematically aggregate into a unique household utility function" (Chiappori, 1988), the Folk Theorem suggests that efficient intra-household allocations can be supported in equilibrium.

Nevertheless, anecdotal evidence coming from different developing countries suggests that households behave in a strongly non-cooperative way: "If my wives knew what I have, they would create new problems to force me to spend my money" (Baland et al. 2011, Cameroon); "You cannot trust your husband. If you leave money at home, he will take it" (Anderson and Baland 2002, Kenya); "[Marriage] is like an unwritten agreement that the husband will turn over his earnings to the wife, but he will filch by declaring 'ghost' expenses/deductions" (Ashraf 2009, Philippines); "Income from 'Male crops' tend to be put to different uses than income from 'female crops' " (Duflo and Udry 2004, Cote d'Ivoire). Furthermore, there have been several empirical works showing that the hypothesis of Pareto optimality and complete insurance within households can be rejected<sup>1</sup>.

This paper also brings direct evidence that households behave in non-cooperative ways. We conducted an extended household survey in the city of Bafoussam (West Cameroon), recording the choices of each adult in the households in terms of consumption, savings, transfers and sharing of information. We observe a very puzzling behavior: spouses do take decision together, make intrafamily transfers, contribute jointly to the public goods, but they hide substantial information regarding income realizations. This behavior is, at first glance, totally incompatible with economic efficiency.

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<sup>1</sup>Udry (1996), Dercon and Krishnan (2000), Duflo and Udry (2004), Dubois and Ligon (2009), Robinson (2012).

As explained by Baland et al. (2011), spouses in Cameroon justify apparently irrational savings behavior as an instrument to protect themselves from pressures coming from both extended families and spouses. They describe their marital ethos saying: “To be happy, live hidden! When a husband knows you have something, he will do anything to have you get the money, until nothing is left. Men here in Africa, to be happy with their wives, shouldn’t set their eyes on their money.” The anecdotal evidence offered by the authors points to the possibility that, in the environment that they study, spouses do not fully communicate with each other. Several other papers (Ashraf, 2009; Dagnelie and LeMay-Boucher, 2009; Chen, 2012) suggest the presence of incomplete information inside the household. We collected direct evidence on the issue by measuring the knowledge of each spouse about the income of his/her partner, in separate interviews. We found that more than 60% of them declared not to completely know the income of their partner. Indeed, when we compare with the actual income of the spouse, we find that about 25% of the respondents are at least 50% off in estimating their spouse’s income.

The possibility that income is not completely observable in the household has not been taken significantly into account until now, and little is known regarding the consequence of incomplete knowledge about preferences or income between spouses. Efficiency can be seriously impaired when there is a problem of revelation of private information. Although there is a consistent literature of games with incomplete information, it has never been adapted within the context of intra-household decision making.

Thus, our main research question is to study the exchange of information about income realizations within the household and its consequence on the provision of public goods. To this purpose, we first study a benchmark model in which spouses finance independently both private and public goods. They have separate interests, do not care about each other’s consumption and make no transfer between themselves as there is no specialization in the provision of any particular good. We assume that the income realization of one spouse is not observable and we study if any informative communication can happen. We find that, in this benchmark case, the cost of misreporting the income realization is not high enough to compensate the gain deriving from an increase in the public good contribution of the other spouse. As a consequence, communication is always uninformative and no separating equilibrium (in which the agreements between the spouses differ as a function of the realized income) exists.

We then introduce two possible rationales for the existence of a commonality of interest between spouses: altruism and specialization due to productivity advantages in providing public goods. In the first case, when spouses’ preferences are altruistic, the cost of misreporting income consists in the utility loss incurred by the other spouse. This induces a partition equilibrium in which the communication process is partially informative.

In the second case, we assume different productivities in public good provision for the two spouses. Here, intra-household transfers and public good specialization constitute

the non-cooperative equilibrium of the symmetric-information benchmark. In presence of asymmetry of information about the income realization of one of the spouses, the communication process is affected by different forces: on the one hand, the spouse whose income is private has an incentive to limit the amount of information that is transmitted in order to reduce free-riding by the other spouse while, on the other hand, both spouses want to channel as much resources as possible to whichever spouse is the most productive at providing public goods. The signaling model that follows from this setting has a (general) separating equilibrium in which intra-household transfers generate a transmission of information that is totally informative.

Finally, we also derive some testable predictions in order to check the empirical relative relevance of the models. When altruism is the main motive of communication, we show that the information content delivered by each spouse should be positively and monotonically correlated with his or her own income share. With intra-household specialization, the relation between the information content of the communication process and the income shares should follow an inverted-U shape, with informative communication occurring only for intermediate values of the income share. The Cameroonian data support the second model.

This paper contributes both to the information transmission literature and the one on private provision of public good in the context of intra-household decision making. As far as we know, we are the first to combine cheap-talk/signaling arguments into a continuous public good game in the household. Our empirical results, which point to the existence of an exchange of information due to interest rather than altruism, can be seen as evidence against cooperative decision making in the household since, in the absence of transfers, inefficient communication takes place.

The paper is structured as follows. In the next section we briefly discuss the state of the literature on the matter. In section 3, we introduce the model and analyze the information transmission without transfers. In section 4, we introduce the different rationals for the existence of commonalities of interests between spouses: altruism and productivity differences in public good provision. Section 5 presents the empirical consequences of the different models and section 6 checks which model better explains the correlations observed in the Cameroonian data. We conclude by summarizing the findings and suggesting avenues for further investigation.

## 2 Related Literature

The seminal works of Samuelson (1956) and Becker (1974) represent the household as a unique entity, either by assuming a household welfare function, or by imagining an altruistic head who “cares sufficiently about all the other members to transfer general resources to them”. However starting with the work of Thomas (1990) and Lundberg et

al. (1997), there has been a substantial amount of evidence showing that the “unitary model” fails to describe the real behavior of households and it became clear that theories more in line with the data were needed.

Following the general game theoretical development in the ‘80s, interaction in the household has then been mainly studied under two classes of models: the non cooperative and the cooperative one. Cooperative behavior is generally characterized by an assumption of efficiency in the usual sense that no other feasible choice would have been preferred by all household members. This approach was originally suggested by Chiappori (1988) and Bourguignon et al. (1993). In the cooperative Nash-bargaining household models discussed in Manser and Brown (1980) and McElroy and Horney (1981) the outcome of household decision making are Pareto-efficient allocations that result from the maximization of the Nash utility-gain production function.

The seminal work of Lundberg and Pollak (1993) has been the first one introducing the possibility of non-cooperative equilibria inside marriage as the outside option of a cooperative bargain. Generally, non-cooperative models use the Cournot-Nash equilibrium concept. Here, each individual within a household is considered to maximize one’s own utility, relative to their own budget constraints, taking the actions of other household members as given. Some examples of this can be found in papers from Lundberg and Pollak (2003), Basu (2006). This class of models has generally been used to formalize the household behaviors observed in developing countries (Anderson and Baland, 2002; Chen, 2011; de Laat, 2008). As Duflo and Udry (2004) explain, the incomes of household members lack of fungibility given that each one has particular claims and that the obligation to share is limited. Even when sharing is expected, spouses can undertake actions to protect their income from the others (Anderson and Baland, 2002; Somville, 2011). Hoel (2012) directly tests through an experiment common assumptions of household models and shows that 97% of choices do not maximize household income. She also finds that private information increase efficiency for a part of the sample. Castilla and Walker (2013) test the effects of private windfalls on public and private expenditures and find that spouses are committed to cash (women) or in-kind investment (men) that are either difficult to monitor or to reverse if discovered by the other partner.

As stated in the introduction, several empirical works have recently documented inefficient allocations and non-cooperative behavior as a result of asymmetric information. However, up to our knowledge, a general theoretical framework incorporating asymmetries of information in the household is still missing. Ashraf et al. (2014), Chen (2012) and Castilla and Walker (2012) are one of the few exceptions that tried to bring some theoretical insights in order to explain empirically observed non-cooperative behavior, though keeping with the existing framework that assumes efficiency of the final allocation and cooperation.

For what concerns public good contribution under incomplete information, it has

most often been viewed as a mechanism design problem or an agency problem (Clarke, 1971; Groves, 1973; Wilson, 1979; Bernheim and Whinston, 1986). Exception to this are Gradstein (1992), that finds, in a dynamic model, that under-provision still occurs when there are asymmetries of information on income and Gradstein et al. (1994) that study whether the neutrality of public good provision still holds when incomplete information on income is introduced. We chose not to have a mechanism design approach since utility redistribution is much more difficult to implement than wealth redistribution. We should then have assumed contracts that are not self-enforcing and that rely on discounted utility of future equilibria. We preferred to concentrate on self-enforcing communication equilibria and study the endogenous communication process. Our approach is thus closer to the cheap talk literature.

The canonical model of cheap talk in Crawford and Sobel (1982) has a different preference structure than ours. We concentrate on the provision of public good to which both spouses can participate. This element is totally absent from their work. There has been a branch of the public good literature that studied whether pre-play communication helps cooperation: Plafrey and Rosenthal (1991) showed, introducing asymmetries of information on outside options and using binary communication, that perfect coordination is not Bayesian-incentive compatible and that agents have weak incentives to free-ride in this kind of game. Contrary to ours, their model has a discrete public good game. Isaac and Walker (1988) added a communication stage to a voluntary contribution model without threshold and observed that communication reduced the free-rider behavior. However, asymmetries of information on resources are totally absent from their model.

In the model with comparative advantages, we match the exchange of information with the exchange of resources, creating a signaling model set up that fits the result of Mailath (1987). Crawford and Sobel (1982) remains the main benchmark of our analysis for the model with altruism.

### 3 Model with Egoistic Preferences and No Comparative Advantages

#### 3.1 Complete information Benchmark

We consider a household in which there are two adult members ( $i = 1, 2$ ). Each member has an individual utility function depending on his private expenditure  $C_i$  and the total public good  $Q$  where  $Q = q_1 + q_2$ . Utility is assumed separable:

$$U_i = u(C_i) + v(q_1 + q_2), \text{ for } i = 1, 2. \quad (1)$$

The functions  $u(\cdot)$  and  $v(\cdot)$  satisfy the standard assumptions that  $u' > 0$ ,  $v' > 0$ ,  $u'' < 0$ ,  $v'' < 0$ ,  $u'(0) = \infty$ ,  $v'(0) = \infty$ ,  $u'(\infty) = 0$ ,  $v'(\infty) = 0$ ,  $u(0) = v(0) = -\infty$ . Since we are mainly interested in conflicts over resources and not conflicts of preferences, we assume the utility functions of the two spouses to be the same. Even though this assumption simplify the analysis, it does not drive the results.

We first study the intra-household Nash equilibrium under symmetric information. We assume the spouses to act individually and non-cooperatively: they maximize their own utility choosing their own level of private consumption  $C_i$  and their own contribution to the public good ( $q_i$ ), given their income ( $Y_i$ ) taking as given the contribution of the other ( $q_j$ ).

$$\text{Max}_{(C_i, q_i)} u(C_i) + v(Q), \text{ for } i=1,2 \quad (2)$$

$$\text{subject to } C_i + q_i \leq Y_i.$$

The FOCs for an interior solution of this game give the optimality condition of the non-cooperative equilibrium:

$$\frac{\partial U_i(C_i, q_i + q_j)}{\partial C_i} = u'(C_i) = v'(q_i + q_j) = \frac{\partial U_i(C_i, q_i + q_j)}{\partial q_i}, \text{ for } i=1,2. \quad (3)$$

This condition says that, for each spouse, the marginal utility of private consumption has to be equal to the marginal utility derived from public good contribution. Given that each spouse's utility depends not only on his/her own contribution to the public good but also on the contribution of the other, we need to understand the interaction between the two. We can define the best response function as:

$$r_i(q_j) = \text{argmax}_{q_i} U_i(C_i, q_i + q_j), \text{ for } i=1,2.$$

Substituting it in the equation (3), we have, for interior solutions :

$$u'(C_i) - v'(r_i(q_j) + q_j) = 0, \text{ for } i=1,2.$$

Using the implicit function theorem, we have:

$$\frac{dr_i(q_j)}{dq_j} = -\frac{\frac{\partial^2 U_i(C_i, q_i + q_j)}{\partial^2 q_i}}{\frac{\partial^2 U_i(C_i, q_i + q_j)}{\partial q_i \partial q_j}} < 0, \text{ for } i=1,2. \quad (4)$$

This means that, when both spouses give positive contributions, each time a spouse will increase his/her participation, the other spouse will decrease his/hers to maintain the

equilibrium between the marginal utility of private consumption and public goods. This is because the two contributions are strategic substitutes, as in Cournot competition.

We can therefore define the optimal consumption bundle of the non-cooperative decision making as:

$$\begin{aligned} q_i^* &= \begin{cases} q_i^* & \text{if } v'(q_i^* + q_j^*) - u'(Y_i - q_i^*) \geq 0 \\ 0 & \text{otherwise,} \end{cases} \\ C_i^* &= \begin{cases} Y_i - q_i^* & \text{if } v'(q_i^* + q_j^*) - u'(Y_i - q_i^*) \geq 0 \\ Y_i & \text{otherwise.} \end{cases} \end{aligned} \quad (5)$$

When the difference of income between the two spouses is very high, the poorest one does not contribute at all to the public good: this is due to the fact that, even if he puts all his income in private consumption, the public good provided by the other spouse is too high to equate the marginal utility of private consumption and of the public good. Thus, there will be two threshold values of the relative income above and below which there will be just one spouse financing the public good.

Despite the fact that the contributions to public goods differ depending on the relative income of the spouses, (3) assures that, for interior solutions, their optimal consumption bundles are the same. Given that they have the same preferences and that they consume the same amount of public goods, for positive contributions, they also consume the same level of private good (that is  $C_i = C_j$ ), regardless of the relative income realizations.

**Lemma 1.** *When both  $q_1^* > 0$  and  $q_2^* > 0$ ,  $U_1(C_1^*, Q^*) = U_2(C_2^*, Q^*)$ . The total level of public good  $Q^*$  is under-provided.*

This result, formulated for the first time by Bergstrom et al. (1986), is very well-known in the literature. The “neutrality” of income redistribution is shown to be valid for any concave preference relationship, as long as all the members of the group contribute. The equality in indirect utility holds only for equal utility functions.

Thus, the presence of public good in the household assures an automatic mutual insurance mechanism between spouses. If one spouses undergoes an income shock, this will be automatically redistributed in the household through the adjustment of public good contributions. At the same time, spouses have incentives to free-ride on each-others contributions to increase their own private consumption. This is reflected by the under-provision result.

How are the asymmetries of information on income going to affect this benchmark setting? In particular, are the spouses able to restore the intra-household insurance mechanism if we introduce a pre-play communication stage?

### 3.2 Asymmetric Information

We introduce here the hypothesis that the income of Spouse 1, the husband, is not completely observable by the other spouse, the wife. However, its probability distribution is known by both spouses and is assumed to be equal to:

$$f(Y_1) = \begin{cases} f(\cdot) > 0 & \text{if } Y_1^L \leq Y_1 \leq Y_1^H \\ 0 & \text{if } Y_1 \leq Y_1^L, Y_1^H \leq Y_1. \end{cases} \quad (6)$$

with  $f(\cdot)$  symmetrically centered around  $E(Y_1)$ . The income of Spouse 2 remains observable by both players. We limit ourselves to a one-sided incomplete information setting for analytical tractability. However, two-sided incomplete information would not change the results of the present section nor of the model with altruism. Its implications for the “comparative advantages” model will be discussed at the end of the next section.

Our goal is twofold: firstly, we want to understand whether the spouses can overcome the information flaw and communicate. Secondly, we want to understand how the introduction of this hypothesis affects the contribution to the public good in the household. Given the well-known under-provision result that characterizes the voluntary provision of public good, we want to see if it is exacerbated or attenuated by asymmetries of information between players.

To study communication between spouses, we introduce a communication phase that takes place before the public good contribution stage. The communication is costless (cheap-talk) in the sense that the utility of spouses does not depend on  $m$ , the message that is sent to communicate. We begin describing the sequence of events and the structure of the set of actions that are chosen in equilibrium by each player. The timing is as in figure 1. There are two stages of the game: the first one in which the information transmission takes place; the second one in which, based on the signal given by Spouse 1, both spouses choose their contribution to the public good.

Once Spouse 1 observes his income realization, he sends a signal  $m$  to Spouse 2. Spouse 2 processes the information content of the message. Then, both players choose their public good contributions.

To analyze this communication game, one first must specify the communication technology. Second, one must model an equilibrium in communication in addition to an equilibrium in the contribution subgame. Third, one must specify how players make inferences from the messages communicated by others. Finally, to solve for an equilibrium, these inferencing rules used by the players must be consistent with the communication strategy at equilibrium.

The equilibrium concept we use, given the introduction of incomplete information, is a Bayesian Nash equilibrium. This means that the strategies are optimal given beliefs (updated according to the Bayes’s rule) and opponents’ strategies. Given that Spouse 2

does not observe Spouse 1's decision rule - but only the message he sends - the game can be considered a simultaneous game (see Crawford and Sobel (1982)) in which Spouse 1 chooses the message and his contribution to the public good and Spouse 2 maximizes her utility choosing her action rule, reacting optimally at each possible signal.

We assume, as communication technology, that  $M = [Y_1^L, Y_1^H]$  is the set of feasible signals. The equilibrium will consist of a family of signaling rules  $h(m|Y_1) : \int_M h(m|Y_1) dm = 1$  and an equilibrium public good contribution  $\mathbf{q}(\mathbf{m}) = (q_1(m), q_2(m))$  such that, if  $m^*$  is in the support set of  $h(\cdot|Y_1)$ , Spouse 1 solves:

$$\text{Max}_{(m, q_1)} U_1(\mathbf{q}_1, \mathbf{q}_2(\mathbf{m})|Y_1),$$

and Spouse 2 solves:

$$\text{Max}_{(C_2, q_2)} E[U_2|m]$$

$$\text{subject to } C_2 + q_2 = Y_2,$$

where

$$E[U_2|m] = \int_{Y_2^L}^{Y_2^H} [u(Y_2 - q_2) + v(q_2 + q_1(x|m))] p(x|m) dx,$$

and where  $p(Y_1|m) \equiv \frac{h(m|Y_1)f(Y_1)}{\int h(m|t)f(t)dt}$ .

When the household plays a non-cooperative Bayesian game with private information on members' income, the contribution of Spouse 2 to the public good (and its private consumption) depends on the **expected contribution** of the other member: this expected contribution is computed taking into account the informative content transmitted in the first stage. Spouse 2 has to update the distribution of income of Spouse 1 according to Bayes' Rule. The bigger the informative content of the message  $m$ , the finer the income distribution will be. Spouse 2 will use this income distribution to maximize her expected utility and to decide her contribution to the public good. Spouse 1, instead, will use this income distribution to compute the contribution of Spouse 2 and to best-react to it, for each state of the world defined by his income realization.

### 3.3 Model with No Altruism and No Transfers

In this part of the paper we are considering the public good as a general expenditure to which both spouses participate. There is no specialization and no transfer of resources between the spouses. This implies that the only cost that Spouse 1 incurs if he decreases the information transmitted to Spouse 2 goes through  $q_2$ : he cannot credibly convince to be of a low type when it happens to be the case since he always has an incentive to declare

the lowest possible type. The only way to have a truthful transmission of information is to make the public good contribution of Spouse 2 independent from the declaration of Spouse 1. This leads to a four-fold result.

**Proposition 1.** *The following holds.*

1. *The communication game has only a pooling equilibrium. That is,  $h(m^*|Y_1) = 1$   $\forall Y_1$ ,  $p(Y_i|m^*) = f(Y_1)$  and  $q_2(m^*) = q_2^* \forall m$ ;*
2. *the Bayesian Nash Equilibrium of a household non-cooperative game of communication and contribution to public good under an asymmetric information regime on the income of the two players exists;*
3. *the BNE is unique;*
4. *in the BNE, the indirect utilities of the two spouses differ ( $U_1^* \neq U_2^*$ ).*

**Proof.** See Appendix ■

Given that income realizations are not verifiable, since Spouse 1 has always an incentive to declare having a lower income than his actual realization, he cannot credibly declare the truth so his communication ends up being uninformative. It is clear that non-trivial communication requires that different types of Spouse 1 have different preferences over Spouse 2's actions. To have more interesting insights on the communication process, there should be a costly trade-off between hiding wealth and contributing to the public good. This will be the object of the next section.

Lastly, before turning to the analysis of the intra-household decision making with transfers, we study how a reduction in the general level of information affects the public good provision in this simple setting. Since spouses are risk averse, the decrease in total provision of Spouse 1 is less than the increase in contribution of Spouse 2 and, in average, ex-ante, the decrease in information increases the level of public good provided.

**Corollary 1.** *Expected Public Good Contribution is higher in the asymmetric information regime than in the complete information one.*

**Proof.** See Appendix. ■

The total public good provided in the complete information regime (CI), when Spouse 1 is provided of the average income, is lower than the expected public good provided in the incomplete information regime (II). This is due to the risk aversion of Spouse 2: even though Spouse 1 reacts to this increase in public good of Spouse 2 by reducing his contribution, in equilibrium the total provision is higher. For a more detailed discussion of public good provision under uncertainty, see Austen-Smith (1980).

Even though we limited ourselves to the study of one public good (for ease of exposition), the results of the current section also hold for a higher number of public goods. The lack of communication result is valid as long as there is one good in which both spouses contribute. The increase in contribution occurs for all the goods for which one of the spouses is risk-averse.

The results in the current section derive from the fact that both spouses contribute simultaneously to the public good without any other interaction between them. They have egoistic preferences, so they care only about their own consumption. Furthermore, since they face the same cost (or the same productivity) in providing the good, they do not have any incentive to exchange resources between them before the actual contribution to the public good occurs. However, in the literature it is well-known that household specialization (Becker, 1991; Browning et al., 2011) and, consequently, transfers occur. The presence of altruism or transfers can drastically change the incentive to exchange information since Spouse 1 faces an higher cost in not providing information to the other spouse. In the first case, he wants to provide his preferred level of private consumption to Spouse 2; in the second case, he wants to give the optimal level of transfers implied by the optimal level of public good. In the next section, we analyze formally these mechanisms.

## 4 Commonality of interest and Communication

### 4.1 Altruistic Preferences with Complete Information

In this paragraph, we introduce the first of the two rationals that we want to study in order to explain the existence of a commonality of interest between spouses: altruism. Spouses are said to be altruistic because they do not care only about their own consumption but also about the (private and public) consumption of the other spouse.

To model this, we change the spouses' utility functions and assume that the utility of Spouse  $i$  depends on his/her private utility plus the utility of the other spouse multiplied by a discount factor  $\delta$  that can takes values between 0 and 1. Thus, each spouse utility looks as follows.

$$\text{Max}_{(C_i, q_i)} u(C_i) + v(Q) + \delta[u(C_j) + v(Q)], \text{ for } i=1,2 \quad (7)$$

$$\text{subject to } C_i + q_i \leq Y_i.$$

When  $\delta$  is equal to 1, each spouse assigns the same wight to his own consumption and the consumption of the other spouse. As  $\delta$  decreases, the importance of individual consumption increases. As  $\delta$  reaches 0, we are back to the case of egoistic preferences.

The new FOCs for an interior solution become:

$$\frac{\partial U_i(C_i, q_i + q_j)}{\partial C_i} = u'(C_i) = v'(q_i + q_j) + \delta v'(q_i + q_j) = \frac{\partial U_i(C_i, q_i + q_j)}{\partial q_i}, \text{ for } i=1,2. \quad (8)$$

Since the term  $v'(q_i + q_j)$  is always positive, it is clear that, in this case, for a given level of PG contribution of the other spouse, spouse  $i$  has to decrease - with respect to the private preferences case - his/her own optimal level of private consumption to increase public good provision. We, thus, have the following lemma.

**Lemma 2.** *When Spouses have altruistic preferences, public good contributions increase when  $\delta$  increases and are always higher than in the egoistic preferences case. Under-provision tends to zero when  $\delta \rightarrow 1$ .*

## 4.2 Egoistic Preferences with Transfers and Complete Information

We are now interested in studying the second rational that could explain why communication takes place in the household. We introduce a different form of intra-household contribution to public goods. We assume that spouses differ in their productivity to provide the public good. Consequently only the more productive spouse, the wife, (directly) contributes to the public good most of the time. The other spouse gives her resources to co-finance the good.

The model in the previous section could be thought of as representing an egalitarian household in which partners do not present any specific talent or advantage and intra-household activities and expenditures are provided separately by both of them: they cook one dinner each, they clean the house, they go shopping and speaking with the teachers of the children in an alternate schedule.

In the current section instead, we have in mind a framework in which the spouses share some tasks like furnishing and taking care of the durable goods of the house, financing children activities, etc. At the same time, there are others in which one of the two has comparative advantages, i.e. grocery shopping for women and maintenance of vehicles for men. It is easier to give cash to the wife to go shopping for all the Saturday dinner menu than to take care of the provision of the ingredients for half the dishes. It is useless to learn the name of all the broken components of your car, in order to buy spare pieces, if your husband can do it for you. However, the expenditure is still shared and the spouses exchange money between them.

With productivity advantages and without intra-household transfers, the new individual maximization problem becomes:

$$\text{Max}_{(c_i, x_i)} u(c_i) + v(q_i + q_j)$$

$$\text{subject to } \begin{cases} C_i + x_i \leq Y_i \\ \alpha_i x_i = q_i \end{cases}$$

for  $i = 1, 2$  with  $\alpha_2 > \alpha_1 > 1$ .

This gives the following first order conditions:

$$\frac{\partial U_i(C_i, q_i + q_j)}{\partial C_i} = u'(C_i) \leq \alpha_i v'(q_i + q_j) = \frac{\partial U_i(C_i, q_i + q_j)}{\partial q_i}, \text{ for } i=1,2. \quad (9)$$

The  $\alpha$ s can be considered as different prices faced by the two spouses. Since the spouses have the same preferences and face different prices, the following equations hold whenever the two spouses consume the same amount of private good ( $C_1 = C_2$ ):

$$u'(C_2) = \alpha_2 v'(q_1 + q_2),$$

$$u'(C_1) > \alpha_1 v'(q_1 + q_2),$$

meaning that Spouse 1 is going to consume more private good than Spouse 2, whenever Spouse 1 is rich enough to contribute to the public good.

We now introduce the possibility of monetary transfers between the two spouses so that the budget constraint now becomes:  $C_i + x_i \leq Y_i - t_i$ .

The new FOCs become:

$$\begin{aligned} \frac{\partial U_i(C_i, q_i + q_j)}{\partial x_i} &= -u'(C_i) + \alpha_i v'(q_i + q_j) \leq 0, \text{ for } i=1,2, \\ \frac{\partial U_i(C_i, q_i + q_j)}{\partial t_i} &= u'(C_i) + \alpha_j \frac{\delta q_j(t_i)}{\delta Y_j} v'(q_i + q_j) \leq 0, \text{ for } i=1,2. \end{aligned} \quad (10)$$

It is clear that, since  $\frac{\partial q_j(t_i)}{\partial Y_j}$  is bounded at 1 and  $\alpha_2 > \alpha_1 > 1$ , there is no equilibrium in which Spouse 2 makes transfers to Spouse 1.

Instead, for some values of relative income and for  $\alpha_2 \frac{\partial q_2(t_1)}{\partial Y_2} > \alpha_1$ , Spouse 1 will find optimal to give money transfers to Spouse 2. Otherwise he will directly contribute on his own.

**Lemma 3.** *If intra-household transfers can occur, there will be two correspondences that, for each level of income of Spouse 1, define two threshold values,  $Y_2^{L*} = g^l(Y_1)$  and  $Y_2^{H*} = g^h(Y_1)$ , such that if  $Y_2^{L*} < Y_2 < Y_2^{H*}$  Spouse 1 transfers resources to Spouse 2.*

**Proof.** See Appendix. ■

Spouse 2 specializes in providing the public good in which she is the most productive and she receives some financing from Spouse 1. The income redistribution does not change spouses' private consumption but increases their utility since it allows resources to be spent more effectively. The transfer occurs for intermediate values of income shares. When the spouse that gives transfers is too poor with respect to the other, he has no reason to give money for financing public good. When he is too rich, if he would give transfers, they would finance private consumption instead of public goods. Since we do not incorporate altruism or binding agreements prior to marriage between spouses in our model, there is no reason of why this should happen.

In figure 2, we present a graphic illustration of the lemma. On the axis there are the income realization of the two spouses. Keeping the income of Spouse 1 constant, we now study how this moves with relative income. The two red lines represent the correspondences that describe the relative income values in which transfers start and stop being given. Being Spouse 1 the less productive in public good provision, for every income level of Spouse 2, we can see four points: the point on the line  $0A$  that indicates the relative income level in which transfers start to increase; the point on the dotted blue line in which the two income are the same and transfers are given; the point on the dotted red line in which, since Spouse 1 is much richer than Spouse 2, he will start lowering transfers to be able to finance only the public good and not private consumption of Spouse 2; the point on the red line  $0B$  in which transfers stop.

As for the joint contribution to public goods in the previous section, we find that transfers take place only when the wealth/income of the two partners is not too different.

### 4.3 Altruistic Preferences with Incomplete Information

We now come back to the altruist model to which we add incomplete information as described in the paragraph 3.2: preferences are now represented as in equation (7). The timeline keeps being the same as in figure 1: Spouse 1 has to send a message to Spouse 2 and then both spouses decide how much to contribute to the public good.

The results, however, are drastically different from the previous section: altruism introduces a strong common interest between spouses. Each time Spouse 1 pretends to be poorer than what he actually is, he induces a reduction of Spouse 2 private consumption that directly affects his own utility. This element puts a lower bound to how much Spouse 1 is going to pretend to be poor. The trade-off between Spouse 1's increase in private consumption and Spouse 2's decrease induces the following result.

**Proposition 2.** *When Spouses have altruistic preferences, the cheap-talk communication game has a partition equilibrium. Communication improves (the size of the partitions reduces) when both  $\delta$  and  $\frac{Y_1}{Y_2}$  increase converging to a separating equilibrium.*

**Proof.** See Appendix. ■

## 4.4 Egoistic Preferences with Transfers and Incomplete Information

We now add asymmetries of information to the intra-household model with transfers. Here, the information transmission is going to be incorporated within the transfer of resources between the spouses: deciding how much to transfer to the other spouse, Spouse 1 is going to decide also the amount of information to transmit.

This setting generates a different endogenous cost of misreporting his income realization for Spouse 1: the equilibrium of the information transmission game will, thus, be different.

In analyzing the transfer exchange and the consequent communication, we are going to assume that the income distribution of Spouse 1 is in the interior of the income space for which transfers occur. We will see afterward how this communication game affects the income space in which transfers occur.

Since, within the intervals where there are no transfers, the results are in line with those in Section 4, we will now concentrate on the information transmission and public good provision that occur when transfers take place, for intermediate values of income shares as we just said. As before, Spouse 1 is the one who makes transfers and whose income realizations are private. We do not analyze the case in which the incomplete information is on the side of the receiver because she would not have, as it was the case in the previous section, any credible way to signal when she has low income realizations, since she always has an incentive to pretend to be of the lowest type possible, both to receive more transfers and to induce the other spouse to contribute more to the public goods.

Figure 3 describes the new time line.

Income of Spouse 1 is realized. He decides the amount of transfers he wants to transmit to Spouse 2 and he gives the money. Spouse 2 updates the information she has on the income of Spouse 1. Public good contribution takes place.

In this game, the transmission of the message  $m$ , that was occurring before, is replaced by the money transfers. Indeed, whenever Spouse 1 decides which transfers to give, it takes into consideration the public good provision he will induce both through the increase in the budget of the other spouse and through the amount of information he will transmit.

Therefore Spouse 1 has to find the optimal transfers  $t^*$  that maximizes:

$$\begin{aligned} & \text{Max}_{(t)} U_1(Y_1 - \mathbf{t} - x_1, \mathbf{q}(\widehat{\mathbf{Y}}_1)|Y_1) \\ & \text{subject to } \begin{cases} C_1 + x_1 \leq Y_1 - t \\ \int_{\underline{Y}(t)}^{\overline{Y}(t)} h(x|t)dx = 1 \end{cases} \end{aligned}$$

where  $\widehat{Y}_1$  is the (average) belief Spouse 2 will have about the income of Spouse 1, knowing that in the second stage  $\mathbf{q}(\mathbf{t}^*)$  solves:

$$\text{Max}_{q_2(\widehat{Y}_1(t^*))} \int_{\underline{Y}_1(t^*)}^{\overline{Y}_1(t^*)} U_2(\mathbf{q}(\mathbf{x}, \mathbf{t}^*)) p(x|t^*) dx$$

$$\text{Max}_{(q_1)} U_1(\mathbf{q}(\mathbf{t}^*)|Y_1),$$

where  $\overline{Y}(t^*)$  and  $\underline{Y}(t^*)$  are respectively the maximum and the minimum income for which giving  $t^*$  as a transfer induces the optimal level of public good provision by Spouse 2 for Spouse 1.

Here there are two countervailing forces that affect the transmission of information and transfers: on one side, Spouse 1 wants to give the exact transfer that generates the optimal level of  $Q$ ; on the other side, he wants to maintain a certain amount of asymmetric information such as to guarantee a higher level of provision of public good by Spouse 2, who decreases her private consumption when there is uncertainty about the public good provided by the other spouse. We will show that the utility function of Spouse 1 satisfies the single crossing condition of indifference curves that guarantee the existence of a separating equilibrium. If  $t^*$  is a separating equilibrium strategy, then  $\widehat{Y}_1 = \overline{Y}_1 = \underline{Y}_1$ .

**Proposition 3.** *A separating (perfectly revealing) equilibrium of the information transmission game with transfers exists iff  $\frac{\partial t}{\partial \overline{Y}_1} > 0$ . A pooling equilibrium exists and is the only equilibrium for  $\frac{\partial t}{\partial \overline{Y}_1} < 0$*

**Proof.** See Appendix. ■

What proposition 3 says is that the communication transmission is partially informative: since Spouse 1 finds optimal to transfer money to the other spouse, while trying to keep a certain amount of asymmetry of information, he is going to reduce, with respect to the complete information case, the amount transferred for each realization of income. The amount transferred is determined depending on the extremes of the income distribution and on the utility functions of the two spouses. Given that Spouse 2 knows that a certain transfer comes necessarily from a certain income level, she will update her beliefs about the income distribution of Spouse 1 and decide her public good contributions accordingly. On the other hand, Spouse 1 optimizes the amount of the transfer in order not to give too much information but, at the same time, to give enough resources. This determines an indifference condition that is satisfied at the margin: the equilibrium is, thus, a separating one.

The intuition behind this result is that Spouse 1 faces a trade-off between the increase in the uncertainty-driven contribution of Spouse 2 and the financing of his preferred amount of transfers. The decrease in private consumption of player 2 compensates the

decrease in public good due to the decrease in transfer: this is because, at the margin, when Spouse 1 communicates perfectly, one unit of decrease in transfer induces more than one unit of decrease in Spouse 2’s private consumption.

Since (net positive) transfers occur only in one direction, a two-sided incomplete information model would not have given any further insight, complicating the theoretical analysis: as stated before, the receiver would not have any incentive to make informative communication. Thus, when deciding how much to transfer, the sender would have to take into account the income distribution of the other spouse and would have, because of risk aversion, less incentive to increase his private consumption. However, the main results should hold.

We now come back to the income set that determines when transfers are given.

**Corollary 2.** *The income space in which transfers occur is shifted towards the left: in equilibrium transfers are under-provided with respect to the complete information case.*

**Proof.** See Appendix. ■

As it is described by figure 4, incentives change differently depending where the income distribution of Spouse 1 happens to be. If it is inside the triangle  $A0B$  the set is not modified. If it is over the line  $0A$ , things change: the increase in expected contribution of Spouse 2 and the incentive to pretend to be poorer shift towards the left (to  $0A'$ ) the income level for which Spouse 1 has an incentive to give transfers. If it is over the line  $0B$  incentives are modified in the other sense: now an increase in transfers gives the signal that Spouse 1 is poorer; therefore the shift is again toward the left.

## 4.5 Further theoretical considerations

Before moving to the empirical part of the paper, we want to discuss some key modeling choices and clarify which environment we think is relevant to our model.

Firstly, we want to clarify why we opted for a single-stage game. Our underlying assumption is that the realization of the state of the world is not verifiable by the uninformed party, even ex-post. Once this assumption is accepted, a repeated interaction framework would change our results only if the agents are able to detect lying by comparing the distribution of declared states of the world with the expected one. Since this requires a non-negligible number of repetitions to be feasible, players have to be very patient and the length of the game has to be long enough for that mechanism to be relevant. However, in our context income is brought home and “shared” with the wife more on a monthly basis than a daily one, which means that the number of repetitions is finite. Furthermore, our model can be particularly valid for one-shot important public good investment decisions for which a repeated-interaction argument would not be appropriate.

Secondly, we want to discuss the hypothesis of ex-post non-verifiability. Even though this hypothesis is not necessary for our results, it is linked to the feasibility of punishments in case of non-truthful communication. The public good contributions that we have in mind are cash expenditure to finance goods ranging from food expenditure to education. Our hypothesis is that the uninformed spouse is able to verify only the value of the observable purchased goods but not the total of the other spouse's expenditures.

Another alternative hypothesis that would deliver equivalent results is that the uninformed spouse uses the observable goods as focal point in the process of information acquisition, so that the informed one has incentive to underinvest in observable goods. This hypothesis could be sustained by empirical regularities showing that, once transfers decrease in the household, not only the communication becomes less precise but also the estimated income by the uninformed spouse decreases (see section 6).

## 5 Testable predictions

Both altruism and intra-household transfers introduce an element of commonality of interest in the household that allows some informative communication. However, the rationale behind the improvement in communication is very different in the two cases, which means that communication will not happen for the same values of the spouses' income shares.

In presence of altruism, Spouse 1 faces a higher cost of lying since pretending to be poorer would decrease the resources available to Spouse 2. The more altruistic is Spouse 1, the higher the cost of lying. Furthermore, the poorer is Spouse 2 with respect to Spouse 1, the costlier it is for Spouse 1 to decrease the private consumption of Spouse 2. That is, the communication process improves both when  $\delta$  and  $\frac{Y_1}{Y_2}$  increase. For a given level of  $Y_2$ , the size of the partition decreases with income since  $\frac{u'(C_1)}{u'(C_2)} \rightarrow 0$ . Hence, communication improves as Spouse 1's income share increases.

In the second case, the cost faced by Spouse 1 derives from the fact that, by reducing the amount of resources transferred to Spouse 2, Spouse 1 cannot achieve anymore his preferred public good contribution. When household transfers occur due to household specialization we observe, for a given  $Y_2$ :

1. if  $Y_1 \in [0, Y_1^{L*})$ : No communication
2. if  $Y_1 \in [Y_1^{L*}, \bar{Y}_1)$ : Completely informative communication through transfers
3. if  $Y_1 \in [\bar{Y}_1, Y_1^{H*})$ : Non informative communication through transfers
4. if  $Y_1 \geq Y_1^{H*}$ : No communication.

This leads to the following testable prediction:

## Result 1

- If *altruism* is the main carrier of information, we should observe a **positive monotonic** relation between communication and spouses' income shares.
- If *intra-household transfers* are the main carrier of information, we should observe an **inverted U shape** relation between communication and spouses' income shares.

We now turn to the analysis of the observational dataset collected in Cameroon to see which model is supported.

## 6 The Cameroonian case study

The Cameroonian Bamileke ethnic group is well known for its economic dynamism. They show an important propensity towards entrepreneurial activities and savings (Dongmo, 1981). Yet, this 'modern' economic activity coexists with the important role of traditional informal networks. The Bamileke people display very strong social ties and are linked together by their religious ancestry (Hurault, 1962, 1970). Even though the extended family, as a whole, plays a very important role, the residential unit of this ethnic group is constituted by the "individual family", e.g. husband, wife and children (Yana, 1997). In other words, the household structure and the individual economic initiative in this region are comparable to those of more advanced economies. Fleischer (2007) describes the Cameroonian family system in those words: "A characteristic [of the system] is the high importance that marriage plays, although conjugal union is increasingly postponed and premarital births are becoming more common (Calvès, 1999). Despite urbanization, an economic crisis and increasing international migration, marriage remains one of the major key life events (Bledsoe and Cohen, 1993), mainly because the conjugal union secures the socio-economic status of both women and men. A gendered division of labor, the separation of responsibilities and the partition of financial means are identified as other attributes of the Cameroonian family system, although profound differences exist between rural and urban areas. The descent is mainly patrilineal and the father remains the acknowledged head of the family even when absent, for example due to migration." Furthermore, as described in Baland et al. (2011), this group exhibits strategic behavior aimed at escaping redistributive pressures both from the extended family and the spouse. Individuals appear secretive with respect to their savings and income, even within the household. The authors report quotes such as "Money is a terrible thing. Nobody should know what you have in your pocket" and "Here we hide money a lot. I hide money from my brothers and my husband. Every time they know I have money, they come with new demands".

The West Region of Cameroon, from which the Bamileke come from, thus represents a rich testing ground for household bargaining and income hiding issues, and we decided to conduct a generalized household survey specifically designed to measure those outcomes. Between April and May 2009, we interviewed 315 households living in the town of Bafoussam, the capital of the West Region. Bafoussam represents a crucial crossroad for monetary flows between the rural world and the economic and administrative capitals, Douala and Yaounde. In each household, we administered a separate individual questionnaire to all the adult members within the household. Each spouse was interviewed in a confidential environment to allow him or her to share private information. We put particular effort to create a link of trust with the respondents in such a way that they would feel free to discuss about secretive and sensible issues such as intra-household relationships and extramarital affairs. We also paid particular attention to avoid that fear of retaliation from spouses could affect answers. Finally, several cross-checks were present in the questionnaires, that were daily checked by ourselves, to be sure to identify incoherent answers. We collected data on a wide range of demographic variables, their occupation, savings and the relationship between the household head and their respective spouses. We collected both direct and indirect measurements of cooperation and knowledge about their spouse's behavior. For the purpose of this paper, we restrict the analysis to the households in which both spouses live in Bafoussam and work, so that our variable of interest - spouses' relative income share - is identified and our model applies. This leave us with a sample of 180 households.

Table 1 provides key descriptive statistics about our sample. The average education in our sample is 8 years, the level in which students end high school. The education difference between men and women is slightly above one year. Men are also slightly older than women. In the sample of all couples living in Bafoussam, the employment rate is 70%, with 31% in regular wage employment. There is a difference of 21 percentage points between men and women. Though this difference is substantial and highly significant, it also shows that there is a sizeable number of women who are actively employed. That is, the households in our sample are quite different from those described in the "separate sphere" bargaining models, in which women specialize in housekeeping activities and men in income-generating ones. Cameroon in general, and the West Region in particular, were traditionally polygamous societies; the women had to take care of their own children and were competing with other cospouses. They had to raise more resources than what was given by the husband and, therefore, developed a higher propensity to work than in other african societies (Yana, 1997). Today, the presence of polygamy almost disappeared - in our sample, less than 1% of the households are polygamous - but the working habit largely remained. The average monthly income per adult is 100 thousand CFA (approximately 100 US dollar), 49.1% of which is derived from regular wage employment, 4.1% from occasional wage employment and 46.8% from self-employment. Men have a much higher

income share (more than 50 p.p. on average).

Table 1 also presents the intra-household contributions to public goods. The main common expenditure in the household is food expenditure, which represents 40% of the household budget on average. All the other common expenditures (education, health and other general) jointly represent about 14%. The average husband's contribution is significantly higher than the wife's, with the exception of food expenditure for which the wife's participation is twice that of the husband. This implies that our model is relevant in this context: there exists at least one public good for which the wife plays an important role and that can be affected by intra-household transfers. Indeed, the wife's expenditure in food is four times more correlated with transfers received from the husband than with household income; it is also ten times more correlated with transfers than with the husband's income and presents a zero correlation with her own income. Finally, spouses spend 18% of their income on personal good (mainly clothes, hairdressing, other goods for body care, alcohol, tobacco), husbands spending significantly more than wives.

The last set of variables measure intra-household cooperation and knowledge of spouse's income. The first variable is a gross measure of transfers between spouses, for which we observe a clear pattern: transfers go from husbands - who transfer 22% of their income on average - towards wives. All (99%) husbands give transfers. In collecting the dataset, we placed emphasis on trying to determine a correct measure of households' decision making processes. To this end, both reported and indirect measures of cooperation and communication were collected. 'Cooperation' is a dummy variable that takes value 1 if the respondent states a preference for a joint management of household resources. From the question "How do you rate your knowledge about the income of your partner? 1 = I know it well; 2 = I know it approximately; 3 = I don't know it", we created the variables 'declared knowledge' and 'declared accurate knowledge' that take the value 1 if the answer to the previous question was respectively different from 3 or equal to 1. 'Estimated spouse income' is the estimation of the income of one spouse by the other spouse. Finally, the variable 'spouse income misperception' is the percentage difference between the actual income and the estimated income by the spouse. As we see from table 1, wives prefer cooperation more often than husbands (there is a difference of 9 p.p.). 81% of the sample declares to have a (more or less accurate) knowledge of the income of the other spouse (this variable is not statistically different between husband and wives) and both spouses underestimate the income of the other spouse by about 40%. 25% of the sample underestimates the partner's income by more than 50%. 10% overestimates it by more than 15%. It is important to mention that 53% of respondents run a small individual business whose revenues are highly volatile and difficult to observe; this creates a scope for hiding resources between spouses.

Correlating the variables cooperation and declared accurate knowledge, we get one of the first intriguing piece of evidence presented in this paper. As shown in table 2,

77.68% of the spouses of this subsample declare to be willing to cooperate with the other spouse when it comes to financial decisions. Surprisingly, 61.92% of them declare not to completely know the income of the partner. More surprisingly, half of those 63.5% declare that they would like to know more but that they still cooperate. The second interesting piece of evidence comes from table 3. Focusing on high values of income share, we correlate the transfers from husbands to wives with the working probability of the wife, while controlling for the income of the husband. We see that transfers increase by an average of 13 thousands CFA in households where the wife is working. This correlation hints at the existence of a positive relationship between the income of the wife and transfers, for high income levels of the husband.

## 6.1 Empirical Specification

From the descriptive statistics, it appears quite clearly that, in the context being studied, the incentives to misinform are rather on the husbands' side. Indeed, on average, they have a much higher wage, make much larger and much more frequent transfers, and are less likely to have a stated preference for cooperation. Therefore, since the model's predictions are valid for a context of one-side comparative advantage, the empirical analysis will focus on husbands' strategic decision to communicate and transfer money.

In the next subsection, we present the two key parts of the empirical analysis. First, we test whether there exists a correlation between husbands' income share and transfers to wives. Second, we estimate the correlation between husbands' income share and wives' knowledge of the husbands' income. Knowledge is successively measured by the variable 'declared knowledge' and by the estimated income. For the altruism model to be valid, we expect a positive monotonic correlation for all estimates. Instead, for the comparative advantage model to be valid, we expect a concave relationship.

In order to be able to discriminate between the two models, we test for the (non-)linearity of the relationship by means of a quadratic specification as well as a more flexible, dummy-variable approach. The first set of regressions focus on husbands and take the form of the following reduced-form equations:

$$T_i = \beta_0 + \beta_1 IS_i + \beta_2 IS_i^2 + \beta_3 C_i + \epsilon_i,$$

and

$$T_i = \gamma_0 + \gamma_1 ISp_{50i} + \gamma_2 ISp_{75i} + \gamma_3 ISp_{99i} + \gamma_4 C_i + \epsilon_i,$$

where  $T_i$  is the variable 'total transfers OUT' from husband to wife in household  $i$  (we focus on the intensive margin given that 99% of the husbands make positive transfers),  $IS_i$  is a continuous variable measuring the income share of the husband and  $ISp_{50i}$  ( $ISp_{75i}$  and  $ISp_{99i}$ ) is a dummy variable that takes value 1 if the income share of the

husband is between the 25th (resp. 50th and 75th) and the 50th (resp. 75th and 99th) percentiles.  $C_i$  is a set of control variables at the household-level that includes household income, household size, husband’s age, education, husband-to-wife relative birth rank shares (which proxies their resource availability, see section 6.3), and extended family size. For the comparative advantage model to hold,  $\beta_1$  has to be significantly positive and  $\beta_2$  significantly negative and both jointly significant; instead, for the altruism model to be valid  $\beta_2$  should not be significantly different from 0. For the second more flexible specification, the comparative advantage model implies that  $\gamma_2$  has to be significantly positive and higher than  $\gamma_3$ ; instead, according to the altruism model,  $\beta_2$  should be significantly lower than  $\gamma_3$ .

The second set of regressions, relating to income, focus on the wife sample and read as follows:

$$Y_i = \beta_0 + \beta_1 S\_IS_i + \beta_2 S\_IS_i^2 + \beta_3 C_i + \epsilon_i,$$

and

$$Y_i = \gamma_0 + \gamma_1 S\_ISp_{50i} + \gamma_2 S\_ISp_{75i} + \gamma_3 S\_ISp_{99i} + \gamma_4 C_i + \epsilon_i,$$

where  $Y_i$  is either the variable the ‘declared knowledge’ or the ‘estimated spouse income’ variable. The variables  $S\_IS$  are the husband’s income share dummies, which are constructed as before. We chose this specification to have estimates at the same relevant points considered for husbands.

## 6.2 Results

In figures 5, we graph the raw correlation between transfers to the wife and the percentile of income share of the husband. Transfers in households in which the husband income share is between percentile 25 and percentile 50 and between percentile 75 and percentile 99 are not different from those whose income share is lower than the 25th percentile, while those that have income share between the percentile 50 and the percentile 75 transfers almost 50 thousands CFA more. The figures present an inverted U-shape correlation, even though confidence intervals overlap.

For a more precise estimation of the correlation, we run the previously mentioned regressions. Results are presented in table 4. In column (1), we have the correlation between transfers and the continuous variable ‘income share’. The correlation has a maximum at 78% and then starts to decrease, showing a concave pattern as predicted by the comparative advantage model. Indeed,  $\beta_1$  is significantly positive,  $\beta_2$  is significantly negative and they are jointly significant at a 10% level. In column (2), we have the correlation with the dummy variables for different percentiles of income shares. The

highest correlation is the one for the income share between the 50th and 75th percentile, which for men corresponds to an income share between 68% and 84%.  $\gamma_2$  is found to be significantly higher than  $\gamma_3$  at a 10% level, corresponding to a reduction of 16 thousand CFA.

We now move to the analysis of the knowledge of spouse’s income realization. 5 presents the correlation between the level of income of the husband estimated by the wife and the transfers received from the husband and his real income respectively. We see that one thousand CFA received increases the estimate of the spouse’s income by 1.34 dollars while the actual husband’s income increases it only by 530 CFA. Indeed, received transfers explain 22% standard deviations of the estimated knowledge while real income accounts only for 15%.

Figure 6 presents the raw correlation of the ‘estimated spouse income’ with the different percentiles of husband’s income share. Again, we see an inverted U-shape correlation, even though confidence intervals overlap. Table 6 presents the reduced form regressions of different measures of intra-household knowledge and income shares. Columns (1) and (3) present the correlation of the dummy ‘declared knowledge’ and the continuous and dummy variables measuring income share, while in columns (2) and (4) the dependent variable is the ‘estimated spouse income’. In column (1) we see that the correlation has a maximum at 60% and that  $\beta_1$  is significantly positive,  $\beta_2$  is significantly negative and they are jointly significant at the 10% level. In column (2) the maximum is reached at 74% of income share and  $\beta_1$  and  $\beta_2$  are jointly significant at the 5% level. The correlations with the dummies of income share, in column (3) and (4), consistently show a maximum for the income share between the 50th and 75th percentile. The difference between  $\gamma_2$  and  $\gamma_3$  is significant at the 1% level in column (3) and at the 10% level in column (4), corresponding to a reduction of 15% in the probability of knowing the husband income and to 121 thousand CFA respectively.

All those correlations point in one direction: the relative income of the two spouses plays an important role in determining both intra-family transfers and knowledge. They support our “comparative advantage” model in several ways. First, they show that income shares have a central role in decision making. Second, more equal shares are correlated with more communication and simultaneous contribution to public goods, a prediction of our model. Although those are just correlations, they are hard to be reconciled with the altruistic model, unless we assume that there exists an inverted U-shape correlation between altruism and income shares. While this possibility cannot be excluded, it seems very unlikely. However, given the endogeneity of resources and income shares, in the next sub-section we present some estimates that we believe help to validate our story that comparative advantages *caused* transfers and informative communication.

### 6.3 Robustness

The first robustness analysis that we implement is aimed at getting rid of endogeneity due to simultaneity of transfers, knowledge of income and income shares. To do so we use a proxy that represents the level of resources available to each spouse during his/her lifetime: his/her relative birth rank, i.e. the rank he/she has in the sibling-hood over the total number of siblings. This measure is particularly appropriate in our context because, as shown by Baland et al. (2014), the Bamileke ethnic group has a precise system of intra-family transfers, mainly used for financing education, that results in being more favorable for younger siblings. As a consequence of this system, younger siblings appear to be more educated and to have more resources over their lifetime.

Therefore, we construct a measure of ‘relative birth rank share’ (own relative birth rank over the sum of own and spouse’s birth rank) in the household that should represent the share of the amount of resources each spouse has in the household. We re-run the previous analysis substituting the continuous variable of income share with the ‘relative birth rank share’. Results are presented in table 7. The ‘relative birth rank share’ presents a concave correlation, with a maximum reached at around 60%, with both intrahousehold transfers, ‘declared knowledge’ and ‘estimated spouse income’.  $\beta_1$  and  $\beta_2$  are jointly significant, marginally so in column (1) and (3) and at the 5% level in column (2).

Another source of endogeneity could come from an omitted variable bias. Spouses with more similar income and resource flows could be more cooperative and transfer more. To (partially) rule out this explanation, we correlate our different measures of resources with the probability of having an extra-marital affair. We consider households in which the husband has an extra-marital affair as being less cooperative. If that was the case, we should observe a U-shaped correlation. Results are presented in table 8. We cannot reject that the coefficients are different from zero in columns (1), (2) and (3). Instead, we find an inverted U-shape correlation in column (4) that we interpret as: households with more similar birth rank are less cooperative.

Another omitted variable bias could be due to the fact that husbands with an intermediate value of income share could be more attached to their women. This would mean that any measure of attachment/altruism should be correlated in the same (positive) way both with transfer and knowledge of income measures. We test this using the probability of having a girl as first child. There are several studies that document the preference for boys in sub-Saharan Africa. For instance, Lambert and Rossi (2014) and Milazzo (2014) show that women who have more sons are less likely to enter a polygamous union or to be divorced. Columns (1) and (2) of table 9 document the presence of a preference for boys in our sample: compared to women with first-born sons, women with first-born daughters have more children. If our story was explained by affection, we should expect,

therefore, a negative correlation between the variable ‘first daughter’ and the transfers and knowledge variable. Columns (3), (4) and (5) show that, if anything, the correlation is positive.

Lastly, if household transfers had an inverted U-shape due to incentive to contribute to public good, we should observe the same correlation for direct public good contributions and income share and no correlation for private expenditures. Table 10 shows that this is indeed the case.

## 7 Concluding remarks

Spouses in Cameroon have imperfect knowledge of each other’s income. Using a dataset we collected in Bafoussam, Cameroon, we find that about 25% of the respondents are at least 50% off in estimating their spouse’s income. However, those spouses have to manage household resources together and to finance joint expenditure. To understand how they overcome issues arising from the existence of asymmetries of information, we have studied public good provision and communication in the household.

We have assumed asymmetric information about the income realizations of one spouse. Firstly, we have shown that, when both spouses contribute separately to joint expenditures, no informative communication can arise. Then, we have introduced two different motives that can induce communication in the household - altruism and productivity advantages - and studied how they affect intrahousehold decision-making. When spouses are altruistic, a partition equilibrium exists: the spouse whose income is private reveals partially his realization of income in order not to reduce too much the private consumption of the other spouse. Conversely, when there is a partial specialization in public goods and transfers of resources occur between spouses, a separating equilibrium arises where no information is concealed. The model thus predict an interval of relative income in which simultaneous public good financing and communication take place, which is showed to be consistent with the correlations found in a first-hand database collected in Cameroon. Our result of partial income revelation in a household where spouses share expenditure and exchange resources is also in line with empirical regularities observed in the data.

For what concerns public good provision, asymmetries of information increase the private consumption of the spouse whose income is not observed but decrease that of the other spouse, in such a way that the total amount provided is higher.

This paper contributes both to the information transmission literature and the one on private provision of public good in the context of intra-household decision making. As far as we know, we are the first to combine cheap-talk/signaling arguments into a continuous public good game in the household. Our empirical results, which point to the existence of an exchange of information due to interest rather than altruism, can be seen as evidence against cooperative decision making in the household since, in the absence of

transfers, inefficient communication takes place.

We developed our analysis in a non-cooperative static setting. Further research should concentrate on the dynamics of household public good provision with asymmetries of information on income and on possible cooperative mechanisms to reach optimality.

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# A Appendix

## A.1 Proofs

### Proof of Lemma 1.

We first prove that  $U_1(C_1^*, Q^*) = U_2(C_2^*, Q^*)$ : if  $q_1^* > 0$  and  $q_2^* > 0$ , then  $u'(C_1^*) = v'(q_1^* + q_2^*) = u'(C_2^*)$ . The result is immediate.

Second, we prove that  $Q^*$  is under-provided: the **Pareto Efficient** allocation is given by the following maximization:

$$\begin{aligned} \text{Max}_{(C_1, C_2, Q)} U_2(Y_1 + Y_2 - Q - C_1, Q) + \mu[U_1(C_1, Q) - \bar{U}_1(Y_1, Y_2, z)] \\ \text{subject to } C_1 + C_2 + Q \leq Y_1 + Y_2 \end{aligned} \quad (11)$$

Deriving the optimality conditions of (11), we obtain the ‘‘Bowen-Lindahl-Samuelson’’ condition:

$$MRS_1 + MRS_2 = \frac{\frac{\partial U_1^E}{\partial Q}}{\frac{\partial U_1^E}{\partial C_1}} + \frac{\frac{\partial U_2^E}{\partial Q}}{\frac{\partial U_2^E}{\partial C_2}} = 1 = MRTF_{Y_1+Y_2, Q}$$

where  $U^E$  is the indirect utility given by the Pareto Efficient allocation. This means that for a consumption bundle to be efficient the sum of the marginal rates of substitution for all players has to be equal to one, implying that every single MRS is lower than one.

In the non-cooperative equilibrium we have that:

$$\begin{aligned} \frac{\partial U_i(C_i^*, q_i^* + q_j^*)}{\partial C_i} = u'(C_1^*) = v'(q_1^* + q_2^*) = \frac{\partial U_i(C_i^*, q_i^* + q_j^*)}{\partial q_i}, \text{ for } i=1,2 \\ \rightarrow \\ \frac{\frac{\partial U_i(C_i^*, q_i^* + q_j^*)}{\partial q_i}}{\frac{\partial U_i(C_i^*, q_i^* + q_j^*)}{\partial C_i}} = 1 > \frac{\frac{\partial U_i^E}{\partial Q}}{\frac{\partial U_i^E}{\partial C_i}} \end{aligned}$$

This means that the marginal utility of public good is higher than what it should be and, thus, the public good is under-provided. ■

### Proof of Proposition 1.

(i) Let us assume that the Bayesian Nash Equilibrium of the communication and public good contribution game exists.

In choosing his communication strategy, Spouse 1 has to find the optimal  $[\bar{Y}(m^*), \underline{Y}(m^*)]$  and  $N$  that solves, for  $i = 1, \dots, N - 1$ :

$$\begin{aligned} U_1(C_1^*, C_{2_{\bar{Y}(i^*), \underline{Y}(i^*)}}^*}, Q_{\bar{Y}(i^*), \underline{Y}(i^*)}^*, \bar{Y}(i)) = U_1(C_1^*, C_{2_{\bar{Y}(i+1), \underline{Y}(i+1)}}^*}, Q_{\bar{Y}(i+1), \underline{Y}(i+1)}^*, \bar{Y}(i+1)) \\ \underline{Y}(0) = Y_1^L \\ \bar{Y}(N) = Y_1^H \end{aligned} \quad (12)$$

Let's define as  $m_L$  as the message that Spouse 1 would send in equilibrium when his income realization is  $Y_1$ . From the best reaction function of Spouse 2, we know that  $q_2(m_L) = q_2^{max*}$ , that means that when Spouse 1 sends the message  $m_L$  Spouse 2 will contribute the most to the public good. Since the Indirect Utility of Spouse 1 is growing in  $q_2$ , whatever his income realization is, he will always declare  $m_L = m^*$ . It follows immediately that  $p(Y_1|m^*) = f(Y_1)$ .

(ii) We now prove the existence of the BNE of the public good contribution. We are going to use the Kakutani Fixed Point theorem following the proof of Athey (2001) applied to a one-side incomplete information environment.

We have to show that:

1. strategies of the two spouses satisfy the single crossing property of incremental returns. That is, for all  $q_i^A > q_i^B$  and  $q_j^A > q_j^B$ ,  $U(q_i^B, q_j^A) > U(q_i^B, q_j^B)$  implies  $U(q_i^A, q_j^A) > U(q_i^B, q_j^B)$ . This is true for all  $Y_1$  and  $Y_2$ .
2. Given  $N$  possible states of the world, the strategy set  $\Sigma$  on which the best responses are applied is a compact, convex and non-empty subset of  $\Re^{N+1}$ .

We study the set of potential action  $\mathcal{A}$  of the two players: for player 2 it coincides with the interval  $[0, Y_2]$ ; for player 1 it can be divided in  $M = N - 1$  intervals in ascending order  $\mathcal{A}_2 = \{A_0, A_1, \dots, A_M\}$  that are defined, in every state of the world  $t$  in the interval  $[Y_1^H, Y_1^L]$  through the correspondence  $\alpha_1 : Y_1 \rightarrow \mathcal{A}$ , where  $\alpha_1$  gives the strategy of player 1 in each state of the world. Since the intervals are in ascending orders we can define the set:  $\Sigma_1 \equiv \{\sigma \in T_1^N | \sigma^0 = Y_1^H \leq \sigma_1 \leq \sigma_2 \leq \sigma_3 \dots \leq \sigma_N = Y_1^L\}$ . Each  $x$  is a component of  $\Sigma_1$  that correspond to a jump point in the step function described by  $\alpha_1$ .  $\Sigma_2 = Y_2$ .  $\Sigma = \Sigma_1 \times \Sigma_2$  is compact, convex and non-empty by construction.

3. The best response correspondence  $\Gamma : \Sigma \rightarrow \Sigma$  is non empty for all  $\sigma$  and is convex for all  $x$ :

We define (expected) payoffs to be  $V_1(Y_1, Y_2)$  and  $V_2 = \sum_{i=0}^M \int_{t_1=\sigma^{m_i}}^{\sigma^{m_{i+1}}} U_2(t_1) f(t_1) dt_1$ . Let  $a_i^{BR} \equiv \text{argmax } V_i$ : this is non-empty by finiteness of  $\mathcal{A}$ . Since  $V_2(\sigma_1)$  is such that  $V_2(\sigma'_1) > V_2(\sigma''_1)$  if  $\sigma'_1 > \sigma''_1$  then  $a_2^{BR}$  is such that there exists a selection  $\gamma_2$  : that determines  $a_2^{BR}$  and is non decreasing. We can define  $\Gamma = \{\gamma_1, \gamma_2\}$  as the best response correspondence. This is ensured to be convex by Lemma 2 in Athey (2001) (since it is non-decreasing in the strong order set).

4.  $r$  has a closed graph. From the definition of the payoff functions and the hypothesis on the density functions (6), it follows that the payoff functions are continuous. So if we have that  $x^k \in \gamma_1(y^k)$  and  $(x^k, y^k)$  converges to  $(x, y)$ : this is straightforward since the payoffs are continuous.

This assures that a Bayesian Nash Equilibrium in pure strategy exists for a discrete action set. When  $N \rightarrow (Y_1^H - Y_1^L)$  ( it converges to this interval because of point 1), the existence of BNE in pure strategy is given by Theorem 2 in Athey (2001), given our assumptions on public good contributions and utility functions.

(iii) Suppose not. Then there exist two BNEs  $q^*$  and  $q^{**}$  with  $q_i^{**t} > q_i^{*t}$  for all states of the world  $t$ . We concentrate on  $i=2$  since the asymmetry of information is on her side.  $q^*$  being a BNE it has to satisfy the following condition for Spouse 2:

$$-u'(Y_2 - q_2^{*t}) + \int_{Y_j^L}^{Y_j^H} p(x|m)v'_i(q_2^* + q_1^{*t}(x))dx = 0.$$

We have that, for every strategy of Spouse 1,

$$\frac{\partial^2 U_2}{\partial c_2 \partial c_2} - \int_{Y_j^L}^{Y_j^H} p(x|m) \frac{\partial^2 U_2(x)}{\partial c_2 \partial q_2} dx < 0, \quad (13)$$

substituting  $q_i^{**}$  for  $q_i^*$  :

$$u'(Y_i^t - q_2^{**t}) - \int_{Y_j^L}^{Y_j^H} p(x|m)v'_i(q_2^{**t} + q_1^{*t}(x))dx < 0.$$

Since the best reaction function of player 1 encompasses that  $q_1^t$  decreases (in every state) if  $q_2^t$  increases, it could be that in the new equilibrium the decrease in the optimal  $s_1^{**t}$  more than compensates the increase of 2, for all  $t$ , and thus, the general level of public good provision decreases and it is guaranteed that:

$$u'(Y_i^t - q_2^{**t}) - \int_{Y_j^L}^{Y_j^H} p(x|m)v'_i(q_2^{**t} + q_1^{**t}(x))dx = 0.$$

But for  $q^{**}$  to be an equilibrium it means that, for all  $t$ , the decrease in the marginal utility of consumption of 1 (due to an increase in private consumption) is exactly compensated by a decrease in the marginal utility of public good, implying that the general level of public good provision has to be higher. But this contradicts the fact that the first order condition of 2 is equal to 0.

If the general level of public good provision does not increase, this contradicts that  $q^{**}$  maximizes the expected utility of 1.

(iv) From Lemma 1, we know that, for interior solutions, the spouses have the same indirect utility, no matter their income.

Now the two spouses have different optimality conditions. For Spouse 2:

$$u'(Y_2 - q_2) = \int_{Y_j^L}^{Y_j^H} p(x|m)v'_i(q_2 + q_1(x))dx,$$

and for Spouse 1:

$$u'(Y_1(x) - q_1(x)) = v'_i(q_1(x) + q_2).$$

This is due to the fact that Spouse 2 best reacts to the expected contribution of 1 and not to his actual one. This means that his private consumption stays constant for all  $Y_1(x) \in [Y_1^H, Y_1^L]$ , for which  $p(x|m) > 0$ , and will be different from private consumption of Spouse 1 that will vary with income. ■

**Proof of Corollary 1.** To show that the public good provided is higher we proceed showing that Spouse 2 increases her expected contribution and that Spouse 1 does not reduce his one to more than compensating the increase.

The fact that, for Spouse 2, the public good provided is higher comes directly from the concavity of the utility function since  $q^* < q^{**}$ , where:

$$\begin{aligned} q^* &: v'_2(q^* + E(q_1)) = u'(Y_2 - q^*), \\ q^{**} &: \int_{Y_1^L}^{Y_1^H} f(x)v'_2(q^{**} + q_1(x))dx = u'(Y_2 - q^{**}). \end{aligned} \quad (14)$$

Now we look at spouse 1 and we show that, for a fixed  $q_2^*$  his expected contribution is equal to what he would have contributed if he had  $E(Y_1)$  with certainty. Given that his expected income is  $E(Y_1)$  and his income distribution is centered around it, we can define  $Y_1^+ = E(Y_1) + \epsilon$  and  $Y_1^- = E(Y_1) - \epsilon$ , where  $Y_1^H \geq Y_1^+ \geq Y_1^- \geq Y_1^L$ .

Since the realized  $q_2^*$  is bigger than what Spouse 2 would have contributed if Spouse 1 would have had  $E(Y_1)$  with certainty, the contribution of Spouse 2 is not only a transfer of resources from state with low income to state with high income (given that the contribution of Spouse 2 is equal in every state) but is an overall increase in PG provision. Given this, we look at the behavior of Spouse 1: from his FOC we know that when he has an increase in income, if not in a corner solution, we have both  $\Delta q < \Delta Y$  and  $\Delta c < \Delta Y$ . Since  $\Delta^+ Y_1 = \Delta^+ q_2 > \Delta^+ c_1 = \Delta^- q_1 \rightarrow \Delta Q = \Delta^+ q_2 - \Delta^+ c_1 > 0$ . However we know that this increase in contribution occurs with an over-contribution in the positive cases and an under-provision in the lower one:  $\Delta^+ q_2 = (Q_2^{II} - Q_2^H) - (Q_2^L - Q_2^{II}) > 0$ . Since we have just shown that there is a constant amount of income that goes in PG contribution and public consumption, we have  $\Delta^+ Q^H = k(Q_2^{II} - Q_2^H) > k(Q_2^L - Q_2^{II}) = \Delta^- Q^L$ .

■

### Proof of Lemma 3.

We first show that, for a given level of income of Spouse 1, there are two levels of relative income that determine whether transfers occur or not.

1. transfers start to occur if  $u'(Y_1 - t_1 - x_1) \leq \alpha_2 \frac{\partial q_2(t_1)}{\partial t_1} v'(q_1 + q_2)$ ;
2. for  $Y_1 \leq Y_2$  then  $u'(Y_1) \geq u'(Y_2)$  so  $u'(C_2) < u'(C_1) \leq \alpha_2 \frac{\partial q_2(t_1)}{\partial t_1} v'(q_1 + q_2)$  and you always have that  $\frac{\partial q(t_1)}{\partial t_1} = 1$  and  $x_1 = 0$ . Thus the condition for giving transfers  $u'(C_1) \leq \alpha_2 \frac{\partial q(t_1)}{\partial t_1} v'(q_1 + q_2)$  is equivalent to the condition for spouse 2 to contribute

to the public good  $u'(C_2) \leq \alpha_2 v'(q)$ ;

3. the problem is equivalent to  $\alpha_2 = \alpha_1$ : there exist two thresholds that delimit the income shares for which the optimality conditions of the maximization problems of Spouse 1 and Spouse 2 give interior solutions.

We now have to show that these thresholds exist for every level of  $Y_1$  and that those thresholds define a correspondence. Suppose not.

Then there exists either:

1. a level of  $Y_1$  in which Spouse 1 gives transfers whatever income Spouse 2 has: this is contradicted on the left if you keep  $Y_1$  at that level and you let increase  $Y_2$  to infinity (he will not give transfer since he will have to satisfy his own consumption) and on the right if you reduce  $Y_2$  to 0.
2. a level of  $Y_1$  in which Spouse 1 does not give transfers whatever income Spouse 2 has: contradicted for  $Y_2 = Y_1$ .
3. several point in which Spouse 1 starts and stops giving transfers: contradicted by the monotonicity of the utility functions.

In particular, since, for positive transfers,  $u'(Y_1 - t_1) = u'(Y_2 - q_2)$ , we have that, when  $Y_1 \rightarrow Y_2 - q_2$ , then  $t_1 \rightarrow 0$ . So for every  $\bar{Y}_2$ , the correspondence will be defined as  $L_1 = \frac{\bar{Y}_1}{\bar{Y}_2} = k_1(\bar{Y}_2)$  and  $k'_1(\bar{Y}_2)$  is lower, equal or bigger then zero depending whether  $-\frac{\partial q_2}{\partial Y_2}$  is lower, equal or bigger then zero.

On the other side, when  $Y_2 \rightarrow Y_1 - t_1$ , then  $\frac{\partial q_2}{\partial t_1} < 1$ . This means that Spouse 1 starts loosing resources when he transfers to his wife. Defining as  $C^T$  and  $Q^T$  the level of private and public consumption at the threshold, we have that, starting from this point, Spouse 1 will transfer  $t_1 = Y_1 - C_T - x_1$  such that  $\alpha_1 x_1 + \alpha_2 t_1 = Q_T$ . We have that at the threshold, when  $Y_1 = Y_T$ , then  $T_1$  is equal to  $Y_T - C_T$  to be able to reach  $Q_T$ . When  $Y_1$  high enough so that  $\alpha_1(Y_1 - C^T) = Q^T$  then  $t_1=0$ , defining the second theshold  $L_2 = \frac{\hat{Y}_1}{\hat{Y}_2} = k_2(\underline{Y}_2)$ . ■

### Proof of Proposition 2.

1. **No separating equilibrium exists:** A necessary condition for the existence of a separating equilibrium (from Mailath, 1987) is that (for simplifying notation  $U_1 = U$  and  $q_2 = q$ )  $\frac{U'_m}{U'_q}$  has to be monotonic in  $Y_1$ . Since  $U'_m = 0$  for all realizations of  $Y_1$  a separating equilibrium cannot exists.
2. **Pooling equilibrium always possible:** As before, to construct this "babbling" equilibrium, assume that  $p(Y_1; m)$  is equal to the prior independent of the message  $m$ . Spouse 2's best response will be to take an action that is optimal conditional only

on his prior information. Hence Spouse 2's action can be taken to be constant. In this case, it is also a best response for Spouse 1 to send a signal that is independent of type, which makes  $p(Y_1; m)$  the appropriate belief.

3. **Existence of partition equilibrium:** We proceed by steps. We first show how the partition is derived and then we show that it is the equilibrium of the communication and public good game.

• **Characterization:**

Spouse 1 has to find the optimal  $[\bar{Y}(m^*), \underline{Y}(m^*)]$  and  $N$  that solves, for  $i = 1, \dots, N - 1$ :

$$U_1(C_1^*, C_{2\bar{Y}(i^*), \underline{Y}(i^*)}^*, Q_{\bar{Y}(i^*), \underline{Y}(i^*)}^*, \bar{Y}(i)) = U_1(C_1^*, C_{2\bar{Y}(i+1), \underline{Y}(i+1)}^*, Q_{\bar{Y}(i+1), \underline{Y}(i+1)}^*, \bar{Y}(i+1))$$

$$\underline{Y}(0) = Y^L$$

$$\bar{Y}(N) = Y_1^H, \tag{15}$$

where  $\bar{Y}(i) = \underline{Y}(i+1)$  and such that  $m^*$  satisfies  $\frac{\bar{Y}(m^*) - \underline{Y}(m^*)}{Y_1^H - Y_1^L} < 1$ .

We show that this is a well-defined difference equation and that it defines an equilibrium  $(q(m), h(m|Y))$  where  $q(m) = \bar{q}(Y_i, Y_{i+1})$  for all  $m \in (Y_i, Y_{i+1})$ .

(i) By the fact that  $\frac{\partial U_2^2}{\partial q \partial Y_1} < 0$ , we have that  $\bar{q}(Y_i, Y_{i+1})$  is decreasing in  $Y_i$  and  $Y_{i+1}$ . Thus, if we take the strictly decreasing sequence  $Y_N, \dots, Y_i$ , with  $N > i$ , there exists only one  $i - 1$  that satisfies (15) since  $v''(\cdot) < 0$  and  $\bar{q}$  is monotonic.

So we can define  $N_{max}(y) = \max\{N - i = 0 : \bar{Y} > Y_N > \dots > Y_{N-i} > \underline{Y} \text{ satisfying (15)}\}$

(ii) Since  $q_2^1 \neq q_2^1$ , by Lemma 1 of Crawford and Sobel (1982) we know that  $\bar{q}(Y_i, Y_{i+1}) - \bar{q}(Y_{i-1}, Y_i) > k$  so that  $\sup N(Y)$  is achieved for  $Y \in (Y_1^L, Y_1^H]$ .

(iii) INDIFFERENCE CONDITION: (15) requires that there exist two levels of Spouse 2's contribution to public good  $q_2^*$  and  $q_2^{**}$ , with  $q_2^* > q_2^{**}$  that induce two equilibria in contribution  $(C_1^*, C_2^*, Q^*)$  and  $(C_1^{**}, C_2^{**}, Q^{**})$  such that  $U_1(C_1^*, C_2^*, Q^*) = U_1(C_1^{**}, C_2^{**}, Q^{**})$ . The equality is due to  $(C_1^* > C_1^{**}, C_2^* < C_2^{**}, Q^* > Q^{**})$  and  $U_{cc} < 0$  and  $U_{qq} < 0$ .

(iv) Spouse 2, in Stage 2, updates  $\int_{\underline{Y}(m)}^{\bar{Y}(m)} h(x|m) dx$ , the income distribution of Spouse 1, based on the message she receives, using Bayes' rule.

Since the variability of  $m$  ( $\Delta m$ ) depends on  $N$  - the number of partition in which  $[Y_1^L, Y_1^H]$  is divided - if  $\frac{\bar{Y}(m^*) - \underline{Y}(m^*)}{Y_1^H - Y_1^L} \rightarrow 1$  then  $N \rightarrow 1$ ,  $h(x|m) \rightarrow f(x)$  and  $\Delta m_1 = 0$ .

Since  $\Delta c_2$  (the consumption of Spouse 2 of which Spouse 1 cares since he is altruistic) depends on  $\Delta m$ , that depends on  $\Delta N$  that depends on  $\frac{\bar{Y}(m^*) - \underline{Y}(m^*)}{Y_1^H - Y_1^L}$ , the optimal  $[\bar{Y}(m^*), \underline{Y}(m^*)]$  will be determined exactly by (15).

• **Equilibrium:**

(i) If the Partition P satisfies the system of equalities above, the message  $m^*(\bar{Y}(i^*), \underline{Y}(i^*))$  is the best response for all  $Y_i \in [\bar{Y}(i^*), \underline{Y}(i^*)]$  since it maximizes:

$$\begin{aligned} & \text{Max}_{(i,m)} U_1(q(m(Y_i^1, Y_{i+1}^1)), Y^1) \\ & \text{subject to } \begin{cases} C_i + q_i \leq Y_i \\ \int_{\underline{Y}(t)}^{\bar{Y}(t)} h(x|m) dx = 1 \end{cases} \end{aligned}$$

This gives the optimal interval  $(\bar{Y}(q^*), \underline{Y}(q^*))$  and  $m^* = t^{CI}(\underline{Y}(m^*))$ .

To see that  $(\bar{Y}(m^*), \underline{Y}(m^*))$  is optimal, consider that  $U_{cc} < 0$  and  $U_{qc} < 0$  and that  $q(m(\bar{Y}(i^*), \underline{Y}(i^*))) > q(m(\bar{Y}(i^* - 1), \underline{Y}(i^* - 1)))$ . This means that for  $Y_1 \in (\bar{Y}(i^*), \underline{Y}(i^*))$  and  $0 \leq k \leq i \leq j \leq N$ :

$$\begin{aligned} & U_1(m(\bar{Y}(i^*), \underline{Y}(i^*)), Y_i) - U_1(m(\bar{Y}(k), \underline{Y}(k)), Y_i) \geq \\ & \geq U_1(m(\bar{Y}(i^*), \underline{Y}(i^*)), \underline{Y}(i^*)) - U_1(m(\bar{Y}(k), \underline{Y}(k)), \underline{Y}(i^*)) \end{aligned}$$

$$\begin{aligned} & U_1(m(\bar{Y}(i^*), \underline{Y}(i^*)), Y_i) - U_1(m(\bar{Y}(j), \underline{Y}(j)), Y_i) \geq \\ & \geq U_1(m(\bar{Y}(i^*), \underline{Y}(i^*)), \bar{Y}(i^*)) - U_1(m(\bar{Y}(j), \underline{Y}(j)), \bar{Y}(i^*)) \end{aligned}$$

(ii) Here we show that maximizing  $\int_{\underline{Y}(m)}^{\bar{Y}(m)} h(x|m) U_2 dx$  is Spouse 2's best response: given that each signal could come uniformly from the interval  $[\bar{Y}(i^*), \underline{Y}(i^*)]$ , when Spouse 2 sees that message she computes:

$$p(Y_1|m^*) \equiv \frac{h(m|Y_1)f(Y_1)}{\int_{\underline{Y}(m^*)}^{\bar{Y}(m^*)} h(m|x)f(x)dx} = \frac{f(Y_1)}{\int_{\underline{Y}(m^*)}^{\bar{Y}(m^*)} f(x)dx},$$

and the conditional expected utility is:

$$\int_{\underline{Y}(m^*)}^{\bar{Y}(m^*)} U_2(Y_2, Y_1) p(Y_1|m^*) dY_1 = \frac{\int_{\underline{Y}(m^*)}^{\bar{Y}(m^*)} U_2(Y_2, Y_1) f(Y_1) dY_1}{\int_{\underline{Y}(m^*)}^{\bar{Y}(m^*)} f(x) dx}.$$

4. **Comparative statics of  $\delta$ :** We claim that  $\frac{\partial(Y_{i+1}-Y_i)}{\partial \delta} < 0$ : proven by Lemma 6 of Crawford and Sobel (1982).
5. **Comparative statics of  $\frac{Y_1}{Y_2}$ :** We claim that  $\frac{\partial(Y_{i+1}-Y_i)}{\partial \frac{Y_1}{Y_2}} < 0$ : it is sufficient to show that it is more expensive for Spouse 1 not to reveal the resources he has when  $\frac{Y_1}{Y_2}$  is higher.

Let's fix the interval of  $[Y_1^L, Y_1^H]$ . Defining  $C_{2j}^o$  as the level of private consumption of Spouse 2 that would solve  $u'(Y_1^j + Y_2 - C_{2j} - Q^o) = \delta u'(C_{2j})$  and  $C_{1j} = Y_1^i + Y_2 - C_{2j} - Q^o$ , we have that:

$$\sum_{Y_1^j \in [Y_i^1, Y_{i+1}^1]} \frac{u'(C_2^*) - u'(C_{2j}^o)}{u'(C_{1j}^*) - u'(C_{1j}^o)}$$

increases when  $Y_2$  decreases, that means for higher  $\frac{Y_1}{Y_2}$ . This means that the interest of Spouse 1 and 2 are closer when Spouse 1 is richer, thus Lemma 6 of Crawford and Sobel (1982) applies.

■

### Proof of Proposition 3.

We proceed by steps. We first show the existence of the separating equilibrium for  $\frac{\partial t}{\partial \frac{Y_1}{Y_2}} > 0$ . We then show the impossibility of separating equilibrium for  $\frac{\partial t}{\partial \frac{Y_1}{Y_2}} \leq 0$ .

EXISTENCE OF SEPARATING EQUILIBRIUM:

The equilibrium is of the type characterized by Mailath (1987). We verify that the utility function of Spouse 1 ( $U_1 = U(Y_1 - t - x_1, \mathbf{q}(\widehat{\mathbf{Y}}_1))$  defined on  $\mathfrak{R}^2$ ) satisfies regularity conditions:

1. **smoothness:**  $U_1$  is  $C^2$  on  $\mathfrak{R}^2$ ;
2. **belief monotonicity:**  $U'_q \frac{\partial q}{\partial \widehat{Y}_1} < 0$ ;
3. **type monotonicity:**  $U''_{Yt} > 0$ ;
4. **strict quasi-concavity:** as we have shown in section 3.3,  $U'_t = 0$  has a unique ( $t^*$ ) solution and  $U''(t^*) < 0$ ;
5. **boundeness:** For a realized income  $Y^R$  Spouse 1 would prefer to send as a signal  $t = 0$  than  $t \geq Y^R$  for which  $U'(c_1) = -\infty$ ;

We now have to verify that also the following condition is satisfied:

- **single crossing:**  $\frac{U'_t}{U'_q}$  is strictly increasing in  $Y_1$  since  $U'_t = -U'_Y \frac{\partial t}{\partial Y_1} + U'_q$  where  $\frac{\partial t}{\partial Y_1} > 0$  and both  $U'_Y$  and  $U'_q$  are decreasing in  $Y_1$ .

By Theorem 2 of Mailath (1987) we know that  $t$  is strictly monotonic on the transfer space and hence continuous and satisfies

$$\frac{\partial t}{\partial Y_1} = -\frac{U'_q}{U'_t}, \tag{16}$$

and has the same sign as  $U''_{Yt}$ . Furthermore, since  $U'_q \frac{\partial q}{\partial \widehat{Y}_1} < 0$  we have that  $t_w = t(Y^T)$  where  $Y^T$  has been defined in Lemma 3.

By Theorem 3 we know that  $t_1$  satisfies incentive compatibility if and only if it solves (16) and the single crossing condition is increasing (decreasing) in  $Y_1$  for  $U_q > 0 (< 0)$ .

To assure that a separating equilibrium exists, we now have to prove that a belief function  $\widehat{Y}_1(t_1)$  exists and is one-to-one and a transfer function  $t^*(Y_1)$  exists such that: for any individual income  $Y_1 \in [\underline{Y}, Y^T]$ ,  $t^*(Y_1)$  maximizes  $U_1$  subject to the belief function, it is one-to-one and feasible ( $t^*(Y_1) \in [0, Y_1]$ ) and fulfills  $Y_1 = \widehat{Y}_1(t^*(Y_1))$ .

We consider the following belief function. Let  $\widehat{Y}_1(t_1)$  be the finite solution of the first order differential equation:

$$\widehat{Y}_1'(t_1) = \frac{1}{q'(\widehat{Y}_1(t_1))} \left[ \frac{u'(\widehat{Y}_1(t_1) - t_1)}{v'(q(\widehat{Y}_1(t_1)) + t_1)} - 1 \right] \equiv \phi(\widehat{Y}_1(t_1), t_1) \quad (17)$$

whose solution exists and is unique with  $\widehat{Y}_{1W} = Y^T$ . In Corollary 1 we have shown that  $0 > q'(Y_1) > -1$ . The first term in parenthesis is growing in  $Y$  monotonically. Since it is equal to 0 for  $Y = 0$ , there must be a level of  $Y^T$  for which it reaches 1. We also have:

$$\begin{aligned} \widehat{Y}_1''(t_1) = & \frac{u''(\widehat{Y}_1(t_1) - t_1)q'(\widehat{Y}_1(t_1))v'(q(\widehat{Y}_1(t_1)) + t_1)}{q'(\widehat{Y}_1(t_1))^2v'(q(\widehat{Y}_1(t_1)) + t_1)^2} (\widehat{Y}_1'(t_1) - 1) + \\ & + \frac{u'(\widehat{Y}_1(t_1) - t_1)q'(\widehat{Y}_1(t_1))v''(q(\widehat{Y}_1(t_1)) + t_1)}{q'(\widehat{Y}_1(t_1))^2v'(q(\widehat{Y}_1(t_1)) + t_1)^2} (q'\widehat{Y}_1'(t_1) - 1) \\ & + \frac{u'(\widehat{Y}_1(t_1) - t_1)q''(\widehat{Y}_1(t_1))v'(q(\widehat{Y}_1(t_1)) + t_1)}{q'(\widehat{Y}_1(t_1))^2v'(q(\widehat{Y}_1(t_1)) + t_1)^2} (\widehat{Y}_1'(t_1)) \end{aligned} \quad (18)$$

Consider the inverse of the belief function  $\widehat{Y}_1(t_1)$ , call it  $t^*(Y)$ . By the slope  $\phi$  of (17), the inverse exists with  $t(Y^T) = t_{max}$  and  $0 < t^* < 1$  for a certain level of  $Y$ . Given this slope,  $t$  is on-to-one. Given that  $t = 0$  for  $Y = L_1$  and the slope for  $Y_1 \in (L_1, Y^T] \rightarrow t_{max}^* < Y^T$ .

We now have to show that  $t^*$  is a global maximizer. Deriving the FOC we have that:

$$-u'(Y_1 - t) + v'(q(\widehat{Y}_1(t_1) + t_1))(q'(\widehat{Y}_1(t_1))\widehat{Y}_1'(t_1) + 1) = 0$$

This is equal to (17) for  $Y = \widehat{Y}_1$  so we have that  $\phi > 1$  and  $0 < t^* < 1$  for all  $Y_1 \in (L_1, Y^T]$ .

The second order condition for a local maximum is also satisfied. Using (17) and (18), we have:

$$\frac{d^2U}{(dt)_{|Y=\widehat{Y}_1}^2} = u''(Y_1 - t)\widehat{Y}_1'(t_1) < 0$$

NON-EXISTENCE OF (SEMI)SEPARATING EQUILIBRIUM:

Here  $q'(Y_1) = 0$  and  $Q = f(\widehat{Y}_1) * t$  with  $f'(\widehat{Y}_1) \leq 1$  and  $f(\widehat{Y}_1) < 0$  so that  $\frac{U_t}{U_q}$  (single crossing condition) is not monotonic in  $Y$  anymore. This means that a separating equilibrium cannot exist anymore.

Furthermore, since the cost of the signal is lower for the worse type and there is no correlation between type and preferred action, there is no scope for a partition equilibrium

either.

#### EXISTENCE OF POOLING EQUILIBRIUM:

To assure that a separating equilibrium exists, we now have to prove that a belief correspondence exists and a transfer correspondence exists such that: for any individual income  $Y_1 \in [Y^T, \bar{Y}]$ ,  $t^*(Y_1)$  maximizes  $U_1$  subject to the belief correspondence and it is feasible ( $t^*(Y_1) \in [0, Y_1]$ ). We try the following belief correspondence ( $p(\hat{Y}_1|t_1) = \int_{Y^T}^{\bar{Y}} f(x)dx$ ) and a transfer correspondence  $t^*(Y_1) = t^*(Y_1^T)$  (where  $Y_1^T$  is defined as the level of income of Spouse 1 at which  $\frac{\partial t}{\partial Y_1}$  start to be negative) are an equilibrium  $\forall Y_1 \in [Y^T, \bar{Y}]$ .

Since  $\frac{\partial t}{\partial Y_1} < 0$ , as for Proposition 1,  $q_2(t(Y_1^T)) = q_2^{max*}$  so he will always send  $t^* = t(Y_1^T) \forall Y_1 \in [Y^T, \bar{Y}]$ . It follows that  $p(\hat{Y}_1|t_1) = \int_{Y^T}^{\bar{Y}} f(x)dx$ .

■

#### Proof of Corollary 2.

We can distinguish three cases:

1.  $Y_1^L > Y_1^{*l} = (g^l(Y_2^{L*}))^{-1}$  and  $Y_1^H < Y_1^{*h} = (g^h(Y_2^{H*}))^{-1}$ : the income set remains unchanged since here as well the problem is equivalent to that in which  $\alpha_2 = \alpha_1$ . Thus, there exist two thresholds  $L_1 = \frac{\tilde{Y}_1}{Y_2}$  and  $L_2 = \frac{\hat{Y}_1}{Y_2}$  that delimit the income shares for which the optimality conditions of the maximization problems of Spouse 1 and Spouse 2 give interior solutions.
2.  $Y_1^L < Y_1^{*l} = (g^l(Y_2^{L*}))^{-1}$  and  $Y_1^H < Y_1^{*h} = (g^h(Y_2^{H*}))^{-1}$ : as shown by Corollary 1  $E(q_2)$  goes up. There are two forces that increase the income level in which transfers starts to be given: the first is that the amount transferred is always the one corresponding to the lower income of the interval in which the income realization occurs (Proposition 2); furthermore:

$$u'(C_1) = \alpha_1 \frac{\partial q_2(t_1)}{\partial Y_2} v'(q_2) > \alpha_1 \frac{\partial E(q_2(t_1))}{\partial Y_2} E(v'(q_2)). \quad (19)$$

So  $C_1$  has to go up and  $t_1$  to go down shifting  $0A$  towards  $0A'$ .

3.  $Y_1^L > Y_1^{*l} = (g^l(Y_2^{L*}))^{-1}$  and  $Y_1^H > Y_1^{*h} = (g^h(Y_2^{H*}))^{-1}$ : here  $\frac{\delta q_j}{\delta t_i} > 0$  since higher transfers are given for lower income realizations so

$$u'(C_1) = \alpha_1 \frac{\partial q_2(t_1)}{\partial Y_2} v'(q_2) < \alpha_1 \frac{\partial E(q_2(t_1))}{\partial Y_2} E(v'(q_2)), \quad (20)$$

and  $C_1$  has to go down shifting  $0B$  towards  $0B'$ .

■

## A.2 Table and Figures

Figures for theoretical analysis

Figure 1: Timeline

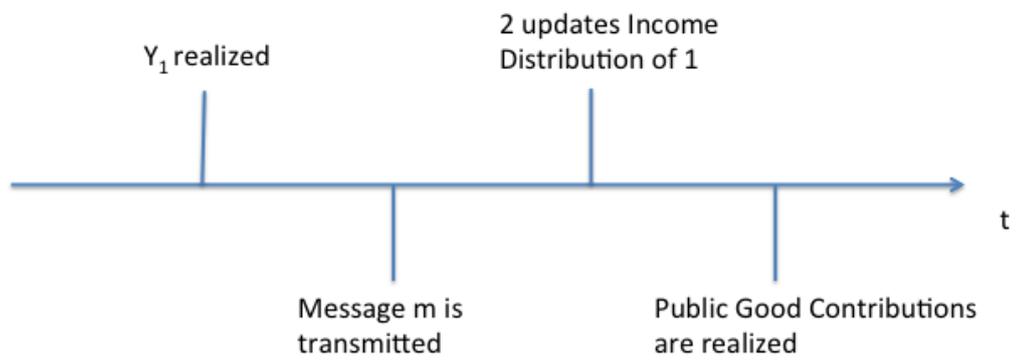


Figure 2: Income and Transfers

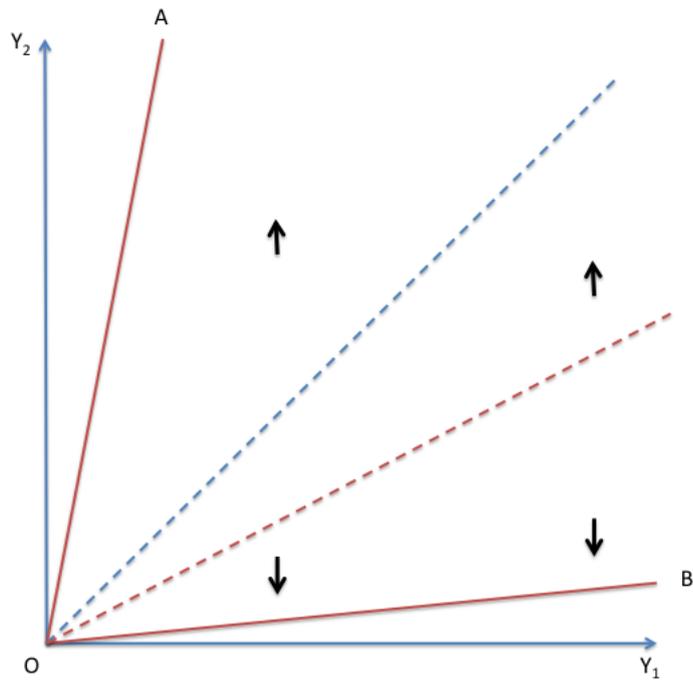


Figure 3: Timeline

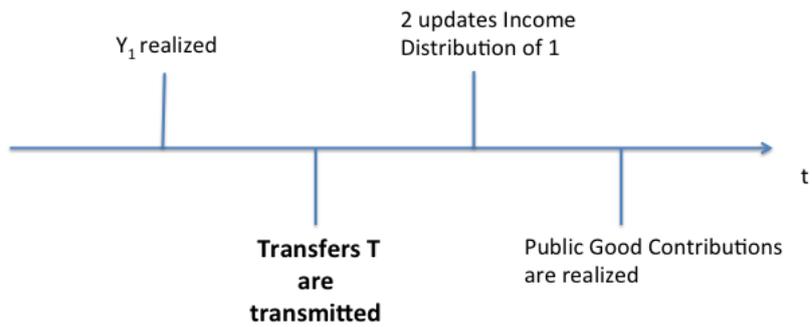
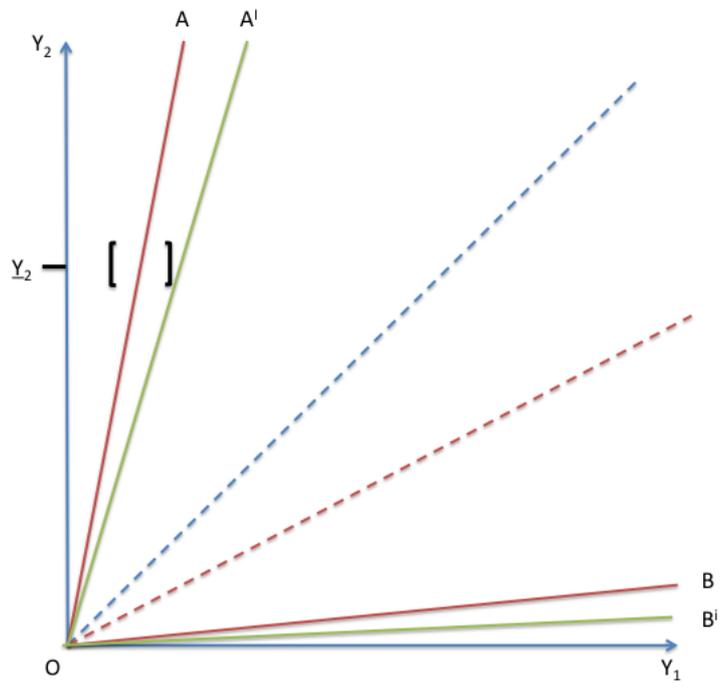


Figure 4: Income and Transfers



## Tables and figures for empirical analysis

Table 1: Mean of key variables

	Total	Men	Women	d
Age	38.02625	41.88584	34.76471	7.121139*** (0.9707731)
Education	8.140811	8.817352	7.493213	1.324139*** (0.3098638)
Any income (d) <sup>†</sup>	0.6940639	0.7990868	0.5890411	0.2100457*** (0.0429753)
Monthly income	100.3677	151.4733	49.26214	102.2112*** (13.78801)
Income share	0.5	0.770746	0.229254	0.5414919*** (0.0302805)
Education expenditure	9.964207	18.21018	1.79057	16.41961*** (3.292445)
Food expenditure	32.37759	20.01416	44.63256	-24.6184*** (3.103257)
Health expenditure	1.611111	1.800393	1.423489	.3769041*** (0.1431569)
Other household expenditures	2.938302	3.663569	2.219396	1.444209*** (.2097775)
Personal Expenditures	18.90445	21.1167	16.94824	4.168461* (2.223471)
Spouse transfers OUT	18.33	35.41495	3.341629	32.07332*** ( 2.0492)
Cooperation (d)	0.7906	0.7429	0.8379	-.0949* (0.0390594)
Declared knowledge (d)	0.8143	0.7938	0.8345	-.0406 (.0479)
Declared accurate knowledge (d)	.4549	.4782	.4341	.0441 (.0640)
Estimated spouse income	62.18248	29.08553	103.418	-74.33251*** (10.93137)
Spouse income misperception	0.3968	0.4123	0.3801	.0321 ( .060)

(d) indicates a dummy variable. Standard errors in parentheses.

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . All monetary variables are in thousands of FCFA.

<sup>†</sup> Using sample of all couples living in Bafoussam (n=442).

Table 2: Household behavior (n=360)

Declared knowledge			
Cooperation	No	Yes	Total
No	20.15%	0.79%	20.94%
Yes	63.3%	15.76 %	79.06 %
Tot.	83.45%	16,55%	100%

Table 3: Transfers and income

Transfers to the Wife (IS>.6)	
Spouse working	13.49428* ( 7.358629)
Personal Income	.1170863* ( .0605395 )
_cons	57.85425*** ( .3.691659 )
<i>N</i>	168
r2	0.0461

Standard errors in parentheses.

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Figure 5: Transfers to wives



Table 4: Transfers to the wife and Income share

	(1) Men spouse_transfers_OUT	(2) Men spouse_transfers_OUT
income_share	982.4912** (479.318)	
income_share2	-626.2769** (304.072)	
.48<IS<.68(d)		34.34324** ( 15.208)
.68<IS<.84(d)		56.33205*** (16.911)
.84<IS<.99 (d)		30.43168** (17.588)
_cons	-226.31418 (225.08069)	99.359 (55.236)
F(joint sig.)	2.34*	
p-value	0.089	
F(p75=p99)		7.503*
p-value		0.0691
N	180	180
r2	0.0326	0.0951

Marginal effects from Tobit estimation; Standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Controls include education, household income, sex, age, relative birth rank, extended family size, household size

Table 5: Estimated and Real Income

	Est. spouse income
Spouse transfers	1.34*** (.37817)
Spouse Income	.539** ( .24301 )
_cons	8.522 ( 79.92 )
F( $\beta_1 = \beta_2$ )	3.05*
p-value	0.0833
N	160
r2	0.0391

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Marginal effects from Tobit estimation; Standard errors in parentheses

Controls include personal income, age, education

Figure 6: Estimated husband income

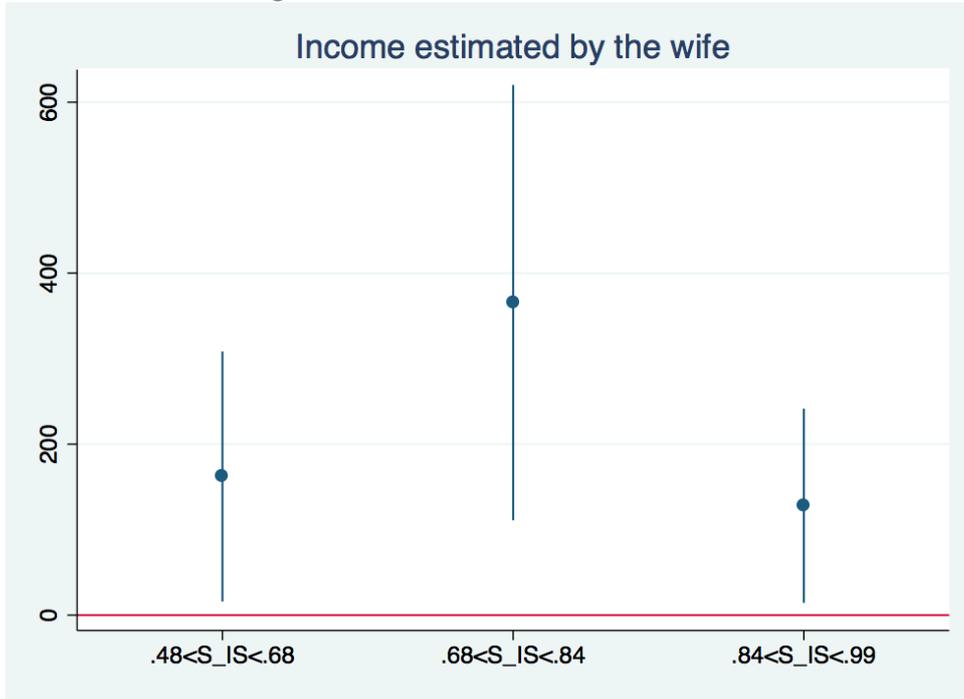


Table 6: Knowledge of spouse income and Income share

	(1) (Women) declared_knowledge	(2) (Women) estimated_spouse_income	(3) (Women) declared_knowledge	(4) (Women) estimated_spouse_income
spouse_income_share	1.018 *** (.2827)	929.6977*** (323.17)		
spouse_income_share2	-.8384*** (.3043)	-621.6619*** (237.5)		
.48<S_IS<.68(d)			.0766 (.0751)	199.6844*** (65.9421)
.68<IS<.84(d)			.18003*** (.0598)	247.5868*** (83.3963)
.84<IS<.99 (d)			.0386 (.0538)	126.136** (52.2752)
_cons	.6788*** (.15894)	-532.951*** (139.007)	.60350*** (.148827)	-375.5862*** (139.007)
F(joint sig.)	7.44***	4.63**		
p-value	0.0008	0.0122		
F(p75=p95)			6.37**	2.98*
p-value			0.0123	0.0876
N	180	160	180	160
r2	0.1060	0.0326	0.1207	0.0214

Linear probability in columns (1) and (3). Marginal effects from Tobit estimation in column (2) and (4); Standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Controls include education, household income, sex, age, relative birth rank, extended family size, household size

Table 7: Proxy for spouse's resources

	(1) (Men)	(2) (Women)	(3) (Women)
	spouse_transfers_OUT	declared_knowledge	estimated_spouse_income
REL_BR_share	159.6462* ( 85.651)		
REL_BR_share2	-131.1343* ( 69.055)		
S_REL_BR_share		1.4893* (.87746)	353.8889* (196.96)
S_REL_BR_share2		-1.1632 (.70137)	-314.7085* ( 166.32)
_cons	-43.273 (38.7248)	.2233 (.7216)	-330.1589** (158.0144)
F(joint sig.)	1.85	1.45	1.82
p-value	0.1625	0.2478	0.1698
N	180	180	160
r2	0.1209	0.0429	0.1232

Linear Probability Mode in column (2); Marginal effects from Tobit estimation in column (2) and (4). Standard errors in parentheses (d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Controls include household income, sex, age, relative birth rank, extended family size, household size

Table 8: Extramarital affairs

	(1) (All)	(2) (Men)	(3) (All)	(4) (Men)
	extramarital_affairs	extramarital_affairs	extramarital_affairs	extramarital_affairs
income_share	0.1083 (0.1689)	0.4173 (0.4628)		
income_share2	-0.1156 (0.1789)	-0.3619 (0.3667)		
S_REL_BR_share			0.2684 (0.1640)	0.6572** (0.3035)
S_REL_BR_share2			-0.2495 (0.1635)	-0.6168** (0.2994)
N	360	180	360	180
r2	0.1209	0.0429	0.1232	0.0536

Linear Probability Model; Standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Controls include household income, sex, age, relative birth rank, extended family size, household size

Table 9: Preferences for boys and household behaviour

	(1) (Tobit) kids	(2) (OLS (Kids>0)) kids	(3) (Men) spouse_transfers_OUT	(4) (Women) declared_knowledge	(5) (Women) estimated_spouse_income
first_daughter	0.5237** (0.2045)	0.3990* (0.2098)	17.99231* (8.0802)	-.01724 (.0721)	25.4454 ( 33.896)
<i>N</i>	227	215	180	180	160
r2	0.2334	0.6433	0.0298	0.0994	0.0370

Marginal effects for Tobit estimation; Standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

For (1) & (2) Controls include education, sex, relative birth rank, extended family size, household income and cohort fixed effects

For (3), (4) & (5) Controls include household income, sex, age, relative birth rank, extended family size, household size

Table 10: Public goods and Income shares

	(1) total_school_fees	(2) personal_expenditure
partner_income_share	88.8292** (41.2130)	14.6153 ( 31.736)
partner_income_share2	-103.6430** (49.0179)	-10.9875 (24.753)
<i>N</i>	180	180
r2	0.0173	0.0402

Marginal effects; Standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Controls include household income, sex, age, relative birth rank, extended family size, household size